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CURIOUS

REMARKS

AND

OBSERVATIONS

IN

PHYSICS, ANATOMY, CHIRURGERY, CHEMISTRY, BOTANY, and MEDICINE.

Extracted from the

HISTORY AND MEMOIRS

OF THE

Royal Academy of Sciences at *Paris*.

CONTAINING

Such useful DISCOVERIES as have not been collected by other Writers on the same Subjects.

Quæ contuens animus, accipit ab his cognitionem Deorum; ex quâ oritur pietas: cui conjuncta justitia est, reliquæque virtutes: è quibus vita beata existit.

Cicero de Naturâ Deorum.

BY

Dr. *PETER TEMPLEMAN.*

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MDCC LIII.

ON·MEDICAL·OBSERVATIONS

TO

Doctor *Benjamin Bosanquet*,
F. R. S.

Dear Sir,

IT is not in the usual stile of dedications that I address this work to you; I only beg leave to inscribe your name, as a friend, philosopher, and physician. In short, I am going to compliment myself rather than you by observing that I follow the example of Cicero in addressing his books of Academics to his friend Varro, who was justly stiled the most learned of all the Romans. As my reasons are the same, I beg leave to make use of the words of Cicero to his friend, *teneri non potui quin conjunctionem studiorum amorisque nostri, quo possem literarum genere, declararem.*

You best know the usefulness of such a work, will be pleased with

the deſign, and candidly excuſe my failings. The *writers*, from whom I have made theſe extracts, ſtand high in the liſt of fame; and by the general voice of Europe, are exceeded only by ſome of *our own*: it gives me an additional pleaſure to find that many of them were phyſicians, not eminent perhaps in practice, but ſuch as had more extenſive views, of being uſeful to their own and future ages.

Mr. De Fontenelle in his elogiums of ſome of *them* hath very prettily as well as juſtly obſerved that "a phy-
"ſician, in order to be in vogue,
"hath often as much to do with the
"fancies of his patients, as with
"their lungs or liver; and he muſt
"know how to phyſic the fancy,
"which requires particular ſpeci-
"fics."

Thoſe *noſtrums* for pleaſing the fancy and humouring the caprices of others are frequently not known, but moſt commonly, diſdained by the truly able and honeſt phyſician.

It

It muſt be acknowledged in honour to the memory of Lewis XIV, that although he oppreſſed religion, he raiſed ſcience, and ſurely he could not have taken a more effectual method for extirpating ſuperſtition and introducing a reformation; for true religion and ſcience have a neceſſary connection and dependance.

Had the ſame encouragement been continued which he begun, and in conſequence of it the ſame ardour and ſpirit ſurvived in all ranks and orders of men for acquiring knowledge; it is highly probable that by this time there would have been ſuch an univerſal light of truth, that ſuperſtition would ſcarce have had a gloomy convent to retire to. But with the death of Lewis theſe hopes expired, new ſchemes of politics aroſe, the encouragement of ſciences began to droop, and though a few have diſtinguiſhed themſelves by a force of genius, yet the generality of

the people have relapſed into their former ignorance.

The decay of the politer arts and ſciences from the death of Lewis is eaſily obſervable in every ſpecies of writing; no more the *numbers* of a Boileau, the *comic humour* of a Moliere, or the *tender ſcenes* of a Racine. From that period alſo I can diſcern a kind of *blight* upon the fruits of the academy, and can juſtly pronounce that very few have given any ſhining memoirs but the *veterans*, that had been formed under Louis le Grand.

That I may not exceed the bounds of an epiſtle I muſt haſten to conclude with aſſuring you that I am,

With the ſincereſt Eſteem and Friendſhip,

Your moſt obliged humble Servant,

Octob. 1, 1753.

Peter Templeman.

PREFACE.

THE hiſtory and memoirs of the Royal Academy of ſciences are ſuch a treaſure of uſeful knowledge in every branch of ſcience, that the moſt eminent writers throughout Europe for theſe fifty years paſt have enriched their works from this noble collection. Yet on a careful review I find a great number of uſeful obſervations, experiments, and illuſtrations, that have wholly eſcaped the notice of thoſe writers, or did not expreſly fall within the ſubjects they were treating of: I have therefore extracted all ſuch curious and remarkable portions, as are of general uſe and importance, and have been unobſerved by others, at leaſt within the compaſs of my own reading.

I conſider myſelf as a ſort of gleaner after the harveſt of others; the grain I pick up diſperſedly *here* and *there* is of the ſame kind and goodneſs as that which they have taken by handfuls: the only difference is that my toil is the greater.

In the proſecution of this work I have omitted to make any extracts of ſuch parts as have been extracted by others, unleſs in ſome few inſtances where their extracts were not ſufficiently ample; and have contented myſelf with directing the reader to the writers, and

the places where thoſe extracts are to be found.

Secondly, I have carefully avoided all imaginary theories, and have admitted no other reaſoning than what neceſſarily reſults, or is with the higheſt degree of probability deducible from the experiments propoſed. I cannot help obſerving that many of the French philoſophers have ſo long fixed their attention on *vortices*, that their heads ſeem to turn and grow giddy with them; for they uſe that term in no determinate ſenſe: for inſtance, the celebrated Mr. De Fontenelle, in ſpeaking of a large body of fire, which he deſcribes as having the figure of a tree and moving from weſt north-weſt to eaſt ſouth-eaſt, yet calls it *un tourbillon de feu* a vortex of fire. *Vid. Hiſtory* 1700, *pag.* 10

Thirdly, I ſhall not take notice of ſuch matters as were formerly the ſubjects of great diſputes and conteſts, but have *long ſince* been compoſed and univerſally acquieſced in. For example, in the year 1692, Mr. Mery propoſed a new theory on the paſſage of the blood through the *foramen ovale* in the fœtus, that it was not from the right auricle of the heart to the left; which was the commonly received opinion: but on the contrary, Mr. Mery inſiſted that the blood moved from the left auricle to the right in paſſing through that foramen. Mr. Du Verney roſe up in defence of the common opinion immediately after the renewal of the academy, and to bat-

tle

tle they went; a great part of comparative anatomy was taken in for auxiliaries. The war laſted ſeveral years with great fury, and even ill manners on both ſides: the Academy was obliged to interpoſe, and deputed proper perſons to examine into the truth of facts alledged by the parties; and altho' ſhe decided ſome points of fact in favour of Mr. Mery, yet the main of the queſtion was left undecided. Even ſo far as the year 1717, Mr. Winſlow appears rather wavering in his opinion.

I have mentioned this queſtion particularly, becauſe few I believe know that it was once the ſubject of mighty heats and controverſies. It is in the philoſophical as in the greater world, the peaceful *inhabitant* of the preſent times enjoys his ſhades and arbours without reflecting, or perhaps knowing, that they were *once* the ſcenes of wars and tumults.

I ſhould not be ſurpriſed if after a certain courſe of years, *this* as well as many other *now ſleeping* diſputes ſhould ariſe. We often find ſome enterpriſing genius in philoſophy, like an ambitious prince, reviving old pretenſions, new furbiſhing ruſty armour, and endeavouring to diſturb the preſent poſſeſſors from the quiet enjoyment of their opinions. Indeed whoever converſes much with old books will find that what are called new diſcoveries are in general only old opinions revived. I could exemplify it by many inſtances,

ces, but it would perhaps be an invidious taſk, and is beſide my preſent ſubject.

The veracity and credit of the academy is ſo well eſtabliſhed, that I am ſatisfied, with regard to facts and experiments recorded in the hiſtory and memoirs, their teſtimony may be conſidered as indubitable. And as an evidence of it I beg leave to cite the 25th article of the original ſtatutes of the academy.

XXVth ARTICLE.

All experiments that ſhall be reported by any gentleman of the academy ſhall be perſormed by him in the aſſembly, if it be poſſible; or at leaſt they ſhall be ſo *in private in the preſence of ſome of the academy deputed for that purpoſe.*

The number of volumes now publiſhed by the academy is ſo great that few would be at the expence of purchaſing, or at the pains of reading them. I hope therefore that the labour I have beſtowed on them will be candidly received.

I ſhall add nothing more than to beſpeak the favour of the public by aſſuring them that my whole ambition is to be uſeful, and that I ſhall dedicate my ſmall abilities, and all the time, which an ill ſtate of health will afford, to their ſervice.

N. B. The edition, to which the references are made, is the Paris edition in quarto.

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Addenda to the article of the pinna-marina, *pag.* 101.

MR. Geoffroy obſerves that we frequently find lodged within the ſhells of the *pinna* little crabs *(Cicero and Pliny call them ſquillæ)* of which the ancients have given us very ſurpriſing accounts.

They imagined that this little animal was born *together* with the *pinna* for *its* preſervation; for which reaſon they have called this animal *the guardian of the pinna*, and thought that the pinna periſhed as ſoon as he loſt his guardian. They judged the little crab to be uſeful to its hoſt in the following manner.

As the *pinna* hath no eyes and is not indued with an exquiſite feeling, whilſt he hath his ſhells *open* and the ſmall fiſh enter within them, the crab gives him notice by a little bite in order to make him cloſe on a ſudden his ſhells; by which means the fiſh are caught, and the pinna and the crab divide the ſpoil between them [b].

Thoſe that have not imagined the crab to have its birth within the ſhells of the pinna, raiſe our admiration of the cunning of this little animal ſtill more, who in order to get within the *ſhells* takes the opportunity when *they* are open to throw *in* a pebble, which prevents

[b] Vid. Ariſtotle hiſt. animal, lib v. cap. xv. Cicero de naturâ deorum. lib 2. 48. Pliny lib. ix. cap. 42. Plutarch de ſolert. animal. Oppian. Halieut. lib. 2. ver. 186.

prevents their being closed and gives him admission for devouring the fish that is within.

But these notions may easily be confuted, for in the first place these little animals are found *indifferently* in all the bivalvular shell-fish, such as oysters and muscles, as well as in the *pinna*; within *whose* shells we find sometimes likewise other small shell-fish; I have a little *concha veneris* that was included, and the fish of it was alive, within the shells of a pinna.

Moreover the *pinna* doth not live on *flesh*, no more than muscles and oysters, but only on water and mud. Thus the pretended artifice of the little crab is useless to *him*.

Lastly, the little crabs do not *eat* the fish of the shells where they lodge; for we find these fish *whole* and *intire* together with the little crabs that accompany them.

It follows therefore that chance alone throws these little animals into the *shells*, whilst *they* are open; or that the animals retire thither in order to shelter themselves, as we frequently find them in the holes of sponges, and stones, and in the external hollows of shells.

GENERAL PHYSICS.

Of hot mineral waters.

THE heat of mineral waters doth not ariſe from a real and actual fire; for they neither ſcald the tongue nor ſoften vegetables, as common water heated to the ſame degree would do; and when put on the fire they do not boil the ſooner for being already hot.

Hiſtory tom. 1ſt, anno 1667, *pag.* 33, *and Memoirs anno* 1707, *Pag.* 113.

The water of Balaruc in Languedoc, ſeems to the touch almoſt as hot as common water that is ready to boil; yet a new laid egg, that has been in it $\frac{3}{4}$ of an hour, has been no more altered, than if it had been in cold water.

Hiſtory anno 1699, *pag.* 55.

The water of Bourbon put on the fire doth not boil ſo ſoon as common water that is cold; the heat that it hath of itſelf is an obſtacle to its acquiring a new heat. When the hot water of the fountain, and com-

mon cold water have boiled on the ſame fire, where they have continued the ſame time; that of the fountain grows cold ſomewhat ſooner; whereas it grows cold ſomewhat ſlower than common water heated to the ſame degree, when it hath not boiled.

Hiſtory anno 1724, *pag.* 47.

Why a veſſel containing water that boils, is not hot at the bottom?

The queſtion was ſtarted one day occaſionally, Why a veſſel full of boiling water hath the bottom leſs hot during the moment that the water, taken off from the fire, ſtill continueth to boil, than when it hath ceaſed to boil? For whilſt the water ſtill boileth, one may touch with the hand the bottom of the veſſel without being burnt, and one cannot do it immediately after the water hath ceaſed to boil. It is neceſſary to add, that for the ſucceſs of the experiment, the bottom of the veſſel muſt be thin, and the veſſel pretty large.

Mr. Homberg ſaid upon it, That he conceived a body to be hot only in conſequence of its being pervaded in all directions by the matter of flame, which iſſuing from all parts with impetuoſity, like an infinite number of little poignant darts, carried into all other bodies, where it darted itſelf, the impreſſions of heat; that when a veſſel is on the fire, the flame, being urged upwards by the gravity of the air, endeavoured to

open

open itſelf paſſages into the water of the veſſel according to that direction; that at firſt it muſt find difficulty to penetrate this water, into which there were no roads, ſuch as its motion required; that at laſt it made itſelf roads, and in that ſtate the water boiled; that then all the paſſages from below, upwards through the water, being eaſily pervaded, the flame, that ſtruck inceſſantly the bottom of the veſſel, went through them without any difficulty; that by conſequence, the veſſel being taken from the fire, the motion of all the little darts at that inſtant was from below upwards, and that they could not hurt the hand which touched the bottom of the veſſel; but that when the water ceaſed to boil, all its parts, being leſs agitated, ſinking, and falling back one upon another, cloſed a great number of paſſages that before were open, which obliged the little darts to eſcape indifferently all manner of ways; and that by conſequence the hand, which was applied to the bottom of the veſſel, muſt receive a great number, and be wounded by them.

The bottom of the veſſel is conſidered *here* only as a ſimple ſurface, which the flame barely paſſes through before it arrives at the water, and on which it no longer acts: But if the bottom hath any thickneſs that is conſiderable, the flame *then* acts neceſſarily, in pervading it, not only from

below upwards, according to the direction given to it by the gravity of the air, but from above downwards, and in all directions, becauſe it is reflected by the ſolid parts; and from thence it is that in that caſe, independently of the different ſtates of the water, the hand will always perceive heat in touching the bottom. If the bottom is thin and at the ſame time the veſſel is narrow, the ſides of the veſſel that ſurround the bottom will communicate to it their heat; and conſequently the veſſel cannot be too large, no more than its bottom too thin.

Hiſtory 1703, *pag.* 24.

Why water can acquire no greater heat than that of boiling.

The preceding little ſyſtem on heat hath furniſhed likewiſe Mr. Homberg with the reaſon of a very ſurpriſing fact, which Mr. Amontons hath diſcovered in making his thermometer, and which hath been of uſe to him in its conſtruction. This fact is, that when water boils as much as it can boil, its degree of heat increaſes no more, although it be kept longer on the fire, or on a more intenſe fire.

The water, according to Mr. Homberg, is hot, or boils, only in conſequence of its being pervaded by the matter of flame, which puffs it up, raiſes it, and makes its ſurface rough and uneven; when this matter hath made itſelf every where free paſſages through the water, the water boils as much

much as it is capable of boiling, and the matter of flame can effect nothing more; thus whether new matter ſucceeds continually, or whether it comes in greater abundance, it can neither more completely open the paſſages, nor open a greater number of them.

Ibidem.

Of water frozen.

Water is the only fluid that in freezing increaſes in bulk, and becomes lighter. Mr. Homberg hath attempted to diſcover the reaſon of it, having drawn away the air with extreme care from a quantity of water, which he expoſed afterwards to a ſtrong freezing; he had a piece of ice entirely tranſparent, and without any bubble; he had marked the height of the water in the veſſel; by being frozen it had not enlarged, it had rather contracted a little.

Hiſtory tom. 2. *anno* 1693, *pag.* 170.

Diſſolves faſter *in vacuo.*

The ſame gentleman hath diſcovered that ice diſſolves much faſter *in vacuo*, than in the open air; the difference was nearly one third of the time.

Ibidem.

Remarkable thickneſs of ice.

In the winter of 1709, the ice of Copenhagen harbour was 27 inches thick in thoſe places where flakes of ice were not heaped one upon another. This fact is ſo much the more obſervable, as in the great froſt of 1683, the Royal Society having cauſed the ice of the Thames, when coaches

went upon it, to be meaſured, it was found to be no more than 11 inches think.

Hiſtory 1709, *pag.* 10.

An obſervation on fluidity.

It is highly probable, ſays Mr. Fontenelle, that the matter of fire cauſes the fluidity of all that is liquid; ſince it is very certain that it makes the fluidity of a metal that is melted, why may it not be ſuppoſed to make *that* of water likewiſe? Is water any thing but ice melted? It is almoſt indubitable, that in the planet Saturn, our water would be for ever ſolid ice, or ſtone; and that in Mercury our metals would be for ever fluid.

Hiſtory 1712, *pag.* 45.

Of petrifying waters.

Father Duchatz relates that the river, which paſſes by the town of Bakan, in the kingdom of Ava, hath in that place, for the ſpace of 10 leagues, the virtue of petrifying wood; and that he himſelf had ſeen there great trees petrified quite to the ſurface of the water, all the reſt ſtill remaining a dry wood. This petrified wood was as hard as a flint ſtone.

Memoirs tom. 10. *anno* 1692, *pag.* 143.

At Clermont in Auvergne there is a petrifying ſpring; from the chemical trials of it by Mr. Lemery, it appears to contain an acid, which probably hath diſſolved ſome ſtony ſubſtance, from the places through

through which it has run. This petrifying water is not *from thence* more dangerous for drinking. In effect, ſtones and what are called ſtones of the bladder have nothing a-kin.

Hiſtory 1700, *pag.* 58.

A remarkable effect from water.

At Senliſſes a village near Chevreuſe, ſituated in a valley at the bottom of a hill, there is a public fountain, the water of which cauſes the teeth to fall out without any flux of ſpitting, without any pain, and without any bleeding. This effect can be attributed to nothing elſe, for the air is very good and very temperate, the inhabitants more robuſt and healthy than elſewhere; only more than half of them are without teeth. At firſt the teeth ſhake in the mouth for ſeveral months, like the clapper in a bell, and afterwards fall out of themſelves. The water that is accuſed for this malady is a conſtant ſtream, and very cold when drank as it iſſues from the fountain; it is found to be an hard water when uſed for dreſſing victuals; and it is ſaid to give the gripes to thoſe that have not been accuſtomed to it. Mr. Aubry, the clergyman of the place, ſends word, that he had been adviſed no longer to uſe it without boiling it firſt, which would cauſe the ill quality of it to evaporate.

Mr. Lemery having examined it in all ways, and put it to all the chemical trials, has not been able to diſcover any thing particular in it: upon a gallon which he cauſed to evaporate by a gentle fire, there remained 12 grains only of a fixt alkali ſalt, which appears a very trifle with regard to ſo great a quantity of water. The cauſe of the bad effect of the fountain of Senliſſes is therefore ſomething too ſubtil and delicate, to be diſcovered by our ſenſes,

Vitruvius ſpeaks of a fountain at Suſa, in Perſia, whoſe water cauſed the teeth to fall out in thoſe that drank it; and it is very remarkable that Mr. Lemery hath ſeen at Paris, a Perſian, born at that city Suſa, who took, when he would, 7 or 8 teeth out of his mouth, and put them in again as eaſily. It is true that he had the ſcurvy to a violent degree. Perhaps the fountain of Senliſſes would occaſion the ſcurvy likewiſe, if the goodneſs of the air, and other favourable circumſtances did not oppoſe it.

Hiſtory 1712, *pag.* 23.

Earthquake at Smyrna.

Mr. Galand came to the aſſembly of the academy the 1ſt of December 1688, and there gave a circumſtantial account of the earthquake that had been felt at Smyrna and in the neighbourhood on the 10th of July preceding. There had been felt a ſhock of another earthquake on the 18th of December

cember 1687, but which was of no conſequence; the laſt began at ¾ after 11 in the morning with a motion from weſt to eaſt; the caſtle was at once demoliſhed, its four walls having gaped open and ſunk down 6 feet into the ſea. This caſtle, which was an iſthmus, is at preſent a perfect iſland, diſtant from the ſhore about an hundred paces in the place where the neck of land hath been cut off. The walls which were from weſt to eaſt are fallen, thoſe that were north and ſouth are ſtill ſtanding.

The city, which is 10 miles diſtant from the caſtle, was almoſt immediately ruined; in ſeveral places were ſeen openings in the earth, and divers ſubterraneous noiſes were heard; there were 5 or 6 ſhocks of the like kind before night, the firſt laſted about half a minute.

The fire caught the greateſt part of the houſes of the town, excepting in the Turks quarter, who at that time kept their *Ramaſan*, or ſolemn faſt, and for that reaſon had no fire in their houſes. Mr. Galand was himſelf enveloped, and as it were buried under the ruins of an houſe for ¼ of an hour. The ground hath ſunk 2 feet in the town, and it is neceſſary at preſent to deſcend, in order to go to certain places on the ſea ſhore, where before it was neceſſary to aſcend. There hath remained no more

than

than $\frac{1}{4}$ of the town, and that principally of thoſe houſes which were ſituated on rocks.

In thoſe parts there blows conſtantly during the ſummer a weſterly wind, which begins about 10 in the morning, and continues increaſing till 4 in the afternoon; and in the ſame ſeaſon the northerly winds, called the *Tramontanes*, are very common in the Archipelago.

On the 11th and 12th, that is to ſay, the two following days, and on the 11th of Auguſt the earthquake began again about 8 in the morning: At length on the 10th of September was perceived a violent ſtench of ſulphur: At the ſame time were felt earthquakes at Metelin, Chio, Satalin, and along the coaſt. In the night between the 10th and 11th, there was felt *one* at Conſtantinople. Mr. Galand had been informed that there had been found *ſince* ſprings of water quite new. During all theſe confuſions the air was very thick and hot, and the notherly wind very ſultry. They reckon that fifteen or twenty thouſand perſons were deſtroyed by this earthquake. The laſt that ravaged Sicily did not cauſe any thing near ſuch havock, nor had ſo long a continuance.

Tom. 2. *anno* 1688, *pag.* 37.

Earthquakes in Italy.

Mr. Maraldi communicated to the Academy ſome accounts he had received of the

the earthquakes that had happened in Italy.

The earthquakes began in Italy in the month of October 1702, and continued to the month of July 1703. The countries that have ſuffered the moſt, and which were thoſe likewiſe where they began, are the city of Norcia, with its dependencies in the eccleſiaſtic ſtate, and the province of Abruzzo: Theſe countries are contiguous, and ſituated at the foot of the Apennine on the ſouth ſide.

The earthquakes were often attended with dreadful noiſes in the air, and often likewiſe thoſe noiſes were heard without any earthquakes, the ſky being very ſerene. The earthquake of the 2d of February 1703, which was the moſt violent of all, was accompanied, at leaſt at Rome, with a great ſerenity of the ſky, and a great calm in the air: It laſted at Rome half a minute, and at Aquila the capital of Abruzzo three hours. It ruined the whole city of Aquila, buried 5000 perſons under the ruins, and made a great havock in the neighbourhood of it.

The nutations of the earth were commonly from north to ſouth, or nearly *ſo*, which was remarked by means of the motion of the lamps in churches. There were in one field two openings made, from whence there iſſued with violence a great quantity

quantity of ſtones that entirely covered the field, and have rendered it barren: after the ſtones there darted forth two water ſpouts, that exceeded in height the trees of that country, continued a quarter of an hour, and overflowed the country all about. This water is whitiſh, reſembling ſoap and water, and hath no taſte.

A mountain that is near Sigillo, a town 22 miles diſtant from Aquila, had on its ſummit a pretty large plain ſurrounded by rocks, which were like walls to it. Since the earthquake of the 2d of February, there hath been in the place of that plain a gulf of an unequal breadth, the greateſt diameter of which is of 25 fathom, and the leaſt of 20: no bottom to it can be found, although they have ſearched 300 fathom deep. At the time that this opening was made, flames were ſeen to iſſue out of it, and afterwards a very thick ſmoke, which laſted three days, with ſome intermiſſions.

At Genoa, on the 1ſt and 2d of July 1703, there were two little earthquakes; the laſt was felt only by people at work on the mole; at the ſame time the ſea ſunk in the harbour 6 feet, and this ſinking laſted near a quarter of an hour.

The ſulphureous water, that is in the road between Rome and Tivoli, is diminiſhed 2 feet and $\frac{1}{2}$ in height, as well in the baſon, as in the foſs. In ſeveral places

of

of the plain, called the *Teſtine*, there were ſprings and rivulets of water that formed unpaſſable moraſſes. All is now dryed. The water of a lake called *Hell* is diminiſhed likewiſe 3 feet in height. In the room of the former ſprings, which are dry, there have iſſued out new ones about a league diſtant from the firſt, in ſo much that it is probable they are the ſame waters which have changed their courſe.

Hiſtory 1704, *pag.* 8.

Earthquake at Lima.

On the 28th of october 1746, there was heard at Lima, at about half an hour after 10 in the evening, a ſubterraneous noiſe, which precedes always, at leaſt in that country, the earthquakes, and laſteth long enough for people to get out of their houſes; the ſhocks came afterwards and were ſo violent, that in 4 or 5 minutes time there did not remain of all that capital above 20 houſes ſtanding; ſeventy-four churches or convents, the palace of the vice-roy, the royal audience room, the hoſpitals, the courts of judicature; and all the public edifices that were more lofty and more ſolidly built than others, were ruined quite to the ground.

Callao a fortified town, and the port of Lima, at 2 leagues diſtance from that capital, was demoliſhed, probably by the ſame ſhocks, at the ſame time, when the earthquake was perceived. The ſea retired from the

the ſhore to a great diſtance, it returned back again with ſo much fury, that it overwhelmed 13 of the veſſels, which it had left ſtranded and lying along ſide in the port, carried away 4 very far into land, whither it extended itſelf a full French league, ſweeping away entirely the town of Callao, and ſwallowing up all its inhabitants to the number of five thouſand, beſides ſeveral of the inhabitants of Lima whom it caught on the road. The oſcillations that the ſea made till it had reſumed its natural bed, covered the ruins of that unhappy town with ſo much ſand, that there ſcarce remains any mark of its ſituation. There had been already found 1141 bodies buried under the ruins, when the veſſel ſet ſail that hath brought this intelligence. They were at work in rebuilding the houſes of Lima, making them ſtill lower than they were before this accident; and it was hoped that, by the prudent precautions of the vice-roy, they ſhould be able to get out of the ruins the greateſt part of the valuable effects that were there buried.

Hiſtory 1746, *pag.* 24.

Vulcanos, earthquakes; hot mineral waters, &c. explained experimentally.

Mr. Lemery hath made an artificial Etna or Veſuvius, having buried in the earth a foot deep 50 pound-weight of a mixture of equal parts of filings of iron and ſulphur in powder, the whole reduced into a paſte with

with a little water. At the end of 8 or 9 hours the earth began to heave, and opened in ſeveral places, ſulphureous and hot vapours iſſuing forth, and at length flames. It is very eaſy to conceive, that a greater quantity of this mixture of iron and ſulphur with a greater depth of earth, was all that was wanting to make a real Etna.

This operation ſucceeds better in ſummer than in winter, on account of the heat of the ſun, which excites a greater inteſtine motion in the imperceptible parts of the iron and ſulphur.

But *here* ſtarts a difficulty, which is, that theſe great fermentations and ſubterraneous conflagrations could not be produced without air: Now it is not eaſy to conceive by what conveyance the air could paſs ſo deep beneath the earth. Mr. Lemery replies to this objection, that there are in the earth many clefts and paſſages which are not commonly ſeen, and principally in the hot countries, where theſe ſubterraneous commotions moſt commonly happen; for the great heat of the ſun calcining in a manner the earth in ſeveral places, cauſes in it deep crevices, through which the air may be introduced. The earthquakes probably are cauſed by a vapour, which having been produced in the violent fermentation of the iron and ſulphur, is converted into a ſulphureous wind, that makes itſelf a paſſage, and

and rowls where it can, lifting up and ſhaking the ground under which it paſſes. If this ſulphureous wind continues confined, without being able to open itſelf a vent to eſcape, it cauſes the earthquakes to laſt a long time, and with great efforts, until it hath ſpent its force. But if it finds any openings to iſſue at, it darts out with great impetuoſity, and makes what is called an hurricane.

Hot mineral waters, ſuch as thoſe of Bourbon, Vichi, Bareluc, Aix, have probably taken their heat from ſulphureous earths through which they have paſſed; for when theſe waters are at reſt, there ſeparates from them *ſulphur* to the ſides of the veſſels containing them.

The water-ſpouts which riſe ſometimes at ſea, and which are to ſailors the ſad preſages of a ſudden ſhipwreck, are owing probably to theſe ſulphureous winds, forced rapidly from the earth, beneath the ſea, after ſuch fermentations as we have been ſpeaking of.

Hiſtory 1700, *pag.* 51, *and Memoirs*, *pag.* 104.

The particles of air not eaſily ſeparable.

Air is not very eaſily ſeparated from other air. If the neck of a bottle hath leſs than 4 lines in diameter, it may be filled with water and turned topſy-turvy, without a drop of water iſſuing from it; becauſe the

air, which muſt enter at one ſide of the neck whilſt the water iſſues at the other, is not eaſily ſeparated into ſuch ſmall parcels as is requiſite. In like manner a bottle that is empty, and whoſe neck ſhould be of the abovementioned diameter, would continue at the bottom of a veſſel full of water, without a drop of water entring into it; and what is very ſurprizing, this would not happen if the bottle was full of wine well refined, and lighter than water; for then the water would fall into the bottle and cauſe the wine to riſe out of it. It follows therefore that wine, though much more heavy and more groſs than air, is much more eaſily divided into ſmall parcels.

Hiſtory tom. 1. *anno.* 1679; *pag.* 271.

N. B. *From this experiment Mr. Senac explains the reaſon why, though the epiglottis be raiſed, water will not enter into the lungs of thoſe that are drowned.*

Vid. hiſtory 1725, pag. 13.

The difficulty of ſeparating the particles of air appears likewiſe from hence. In ſolutions of ſalts or metals we ſee bubbles of air riſe from the bottom of the liquor quite to the top, loaded with ſaline or metalline particles. When the bubbles are arrived at the top, they unite themſelves to the external air, and the particles which they had raiſed fall

back again: as theſe particles are ſpecifically heavier than the air, it cannot raiſe them but by attaching itſelf to them with a certain force, and in ſuch manner that the whole maſs muſt be lighter than the liquor that it traverſes in mounting. Now in this *little whole*, the quantity of air muſt be of a greater bulk than the ſaline or metalline particle, for otherwiſe the whole maſs would not be ſufficiently light to aſcend. From thence it follows that the particle which is raiſed is not attached to all the air that raiſes it, and conſequently it tends by its weight to ſeparate the parts, to which it is adherent, from thoſe to which it is not adherent; and ſince it doth not ſeparate them the one from the other, they muſt have a certain union together that prevails over that effort.

Hiſtory 1731, *pag.* 2.

Vipers and frogs live in the exhauſted receiver.

Neither the viper nor the frog die, although the air hath been pumped out of the veſſel wherein they are included, as Mr. Homberg hath often made the experiment before the gentlemen of the academy.

Memoirs tom, 10th, *anno* 1693, *pag.* 397.

N. B. *By Mr. Boyle's experiments they died, but not 'till after many hours.*

Vid. Boyle's works, vol. 3. *pag.* 115.

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This difference may be owing probably to this, that Mr. Boyle's exhauſted receiver made a more perfect vacuum, than that of the academy.

The reſiſtance of air and water to ſudden motion.

Mr. De la Hire obſerves, that the reſiſtance to motion is by ſo much the greater, as the motion is more ſudden; and when it is *ſo*, to ſuch a degree that what reſiſteth hath not the time to recede, then a body very weak of itſelf may ſupply the place of *one* that is unmoveable, and of an invincible obſtacle. It is for this reaſon that air and water, ſtruck with ſuch velocity, and with ſo ſudden a blow, that they have not time to recede, become fixed points, the one for the flight of birds, the other for the action of oars.

Hiſtory 1702, *pag.* 11.

Inſtances of early ripeneſs in a boy.

A magiſtrate of Beſanzon hath ſent word to the academy, that there was near mount St. Claude a boy, that at the age of ſix months began to walk; at 4 years old he appeared capable of the act of generation; at ſeven years of age he had a beard, and the ſtature of a man; he was then ten years old when the magiſtrate ſent this account.

Hiſtory tom. 2. *anno* 1695, *pag.* 234.

In a girl.

A ſuitable match for that boy, bating in point of time, was a girl whom Mr. De Langlade, a ſurgeon of Carcaſſone, hath ſent

word to Mr. Du Verney, that he had ſeen in his own country; ſhe was born the 8th of February 1704, had her courſes 8 days, or according to other accounts, 3 months after her birth; ſhe was then, at the age of a little more than 4 years, 3 feet and half high; all the body well proportioned to her height, the breaſts and the parts of generation as in a girl of 18, inſomuch that ſhe appeared perfectly marriageable. Mr. De Langlade had made with care all the obſervations neceſſary. Girls in the Eaſt-Indies which travellers aſſure us have children by 9 years old ceaſe to be a wonder.

Hiſtory 1708, *pag.* 52.

Remarkable youth of an old woman.

The ſame Mr. De Langlade hath ſent word likewiſe, that a phyſician had very lately aſſured him that he had ſeen a woman 106 years old, who had ſtill her courſes.

Ibidem.

Another inſtance.

The late biſhop of Sees, declared that a man of his dioceſe, and whom he knew, 94 years old, had married a woman of 83, with child by him, who was brought to bed of a boy at her full time.

Hiſtory 1710, *pag.* 16.

Terrible effects from corrupted rye, in a letter from Mr. Dodart.

Some years ago Mr. Perrault gave an account to the academy, that in paſſing through Sologne, he had heard from the phyſicians and

and ſurgeons of the country, that the rye was ſometimes corrupted in ſuch manner, that the uſe of the bread, into which much of that corrupted grain had entered, cauſed to fall off mortified from *ſome* one part, from *others* another; and that one for example loſt a finger, another an hand, another his noſe, *&c.* And that this gangrene was not preceded either by fever, inflammation, or conſiderable pain, and that the gangrened parts fell off of themſelves, without any need of being ſeparated by any applications.

Memoirs tom. 10. *anno* 1676, *pag.* 561.

N. B. The reſt of the account being cited, and fully repreſented, in the philoſophical tranſactions, (Vid. Lowthorp's abridgement, vol. 2d, pag. 625.) I need not make any further extract of it.

The horizontal moon ſolved.

Father Gouye conjectures that, when the moon is in the horizon, the proximity of the earth, and the denſer vapours, with which that luminary is *then* enveloped in reſpect to us, produce the ſame effect as a wall placed behind a column, which appears then much bigger than if it ſtood alone, and environed on all ſides by a clear air. Again, a column if it is *fluted* appears bigger than when it is not *ſo*, becauſe the flutings are ſo many particular objects, which by their multitude give room to imagine that the total object which

they compoſe is of a greater ſize: of the like kind and efficacy are all objects that lye ſpread on that part of the horizon, to which the moon correſponds, when ſhe is near it; and from thence it is that ſhe appears much larger when ſhe riſes behind trees; the more cloſe and diſtinct intervals of which produce almoſt the ſame effect on the apparent diameter of this planet, as a greater number of flutings on the ſhaft of a column.

Hiſtory 1700, *pag.* 9.

A peculiar kind of ſerpent in Brazile.

Mr. Couplet, the younger, in a letter to the Abbé Bignon, preſident of the academy, ſays, I could never caſt my eyes on thoſe aſtronomical obſervations, that I made at Paraiba, without recollecting an accident that happened to me there at the ſame time. As I believe no author hath ſpoke of the like kind of thing, you will perhaps be well pleaſed to ſee it here. There is in Brazile a ſort of ſerpent about 2 feet long, and between 3 and 4 inches round, which the Portugueſe call the two headed adder, not that it really hath two heads, as I have clearly perceived after examining it with care, it hath only at the end of the tail a *bigneſs*, which hath at a diſtance ſome reſemblance of an head. The Brazilians, and after them the Portugueſe, have been the more eaſily induced to take it for an head, as they are extremely fearful of this kind of adder, to the ſting of which

which they pretend there is no remedy. They know likewiſe that it is dangerous to touch it after it is dead, and probably that has hindered them from examining it. They gave me warning that the touching it alone would occaſion a ſcab; I neglected an advice ſo ſalutary, which I conſidered as an effect of their timorouſneſs, but I was puniſhed for my raſhneſs; for having killed ſeveral of theſe adders, I ſkinned ſome of them in order to examine them, and to preſerve their ſkins; two or three days after I found myſelf quite covered with puſtules, that were full of a red water; they laſted on me a long time; and even three months after I was not entirely rid of them.

There are in the country adders of an extraordinary bigneſs, I killed one of them with a muſket ſhot in the woods between Paraiba and Pernambouc, which was more than 15 feet long, and between 16 and 18 inches round; it was all covered with ſcales, black, white, grey, and yellowiſh, which all together had a very pretty effect. The bite of theſe adders is venomous; nevertheleſs the Brazilians and the blacks make no difficulty of eating their fleſh. This need not appear more ſtrange than what is obſerved in the Manioc, of which a kind of bread that is made is the moſt common aliment in Brazile, and the juice of which is a poiſon, as I experienced on a Terrier dog, to whom

I gave leſs than half a wine glaſs of it about 8 in the evening. I obſerved the dog for ſome time, without remarking any ſenſible change in him; I ſhut him up at night, and the next morning I found him dead.

Memoirs 1700, *pag.* 177.

Mr. Felibien, a member of the academy of inſcriptions, hath ſent an account to the academy of ſciences, of a ſingular event, perhaps never before heard of, that hath juſt happened at Chartres.

Remarkable caſe of a man born deaf.

A young man between 23 and 24 years old, a tradeſman's ſon, deaf and dumb from his birth, began all of a ſudden to ſpeak, to the great amazement of the whole town. They learnt from him that 3 or 4 months before he had heard the ſound of the bells, and had been extremely ſurprized at this new and unknown ſenſation. After this there had come away a kind of water from his left ear, and he heard perfectly with both ears: he continued thoſe 3 or 4 months to liſten without ſaying any thing, accuſtoming himſelf to repeat aſide the words that he heard, and confirming himſelf in the pronunciation, and in the ideas affixed to the words. At length he thought himſelf in a condition to break ſilence, and he made known that he ſpoke, though it was yet but very imperfectly. Able divines ſoon enquired of him concerning his paſt ſtate, and their principal queſtions

were concerning God, the ſoul, and the moral good and evil of actions: he did not appear to have carried his thoughts ſo far; although he was born of catholic parents, was uſed to be preſent at maſs, was inſtructed to make the ſign of the croſs, and to kneel with the countenance of a man at devotion, he had never joined to all That any intention, nor comprehended what others joined to it; he did not very diſtinctly know what death was, and had never reflected on it; he led a life purely animal, entirely taken up with thoſe objects that immediately ſtruck his ſenſes, and with the few ideas that he received by his eyes; he did not even infer, from the comparing thoſe ideas, all that one would think he might have inferred. This is not owing to his not having naturally a good underſtanding; but the underſtanding of a man, deprived of the commerce of others, is ſo little exerciſed, and ſo little cultivated, that he thinks no more than what he is indiſpenſibly forced to by external objects; the great fund of the ideas of men is in their reciprocal commerce.

Hiſtory 1703, *pag.* 18.

A remark on the thermometer.

It muſt appear very ſurpriſing that, when the ball of a thermometer is covered with the hand, in order to warm the liquor included, and to make it aſcend in the tube, the liquor at firſt ſinks down, and does not aſcend

aſcend above its former level 'till after that motion, ſo irregular in appearance, and ſo contrary to what one would have expected. Mr. Amontons, who ſpoke of it on occaſion of his new thermometers, imputes this motion, in which the liquor ſinks at firſt, to the rarefaction, that the warmth of the hand occaſions in the ſubſtance itſelf of the glaſs of the ball, before it cauſes any in the liquor. The capacity of the ball increaſes therefore, and of conſequence the liquor of the tube deſcends, 'till it hath got ſufficient heat to mount upwards, notwithſtanding the enlarged capacity of the ball.

On the contrary, the application of ſnow to the ball of the thermometer, cauſes the liquor at firſt to aſcend in the tube.

Vid. tom. 2. *anno* 1684, *pag.* 394.

Mr. Amontons hath calculated upon very exact experiments, how much the capacity of the ball was enlarged, and hath found it to be no more than a thouſandth part. This thouſandth part, in which the ball is enlarged, and which is the quantity of liquor that enters it, or that ſinks, will become ſo much the more perceptible on the tube, as the capacity of the tube ſhall be ſmaller in proportion to that of the ball.

Hiſtory 1704, *pag.* 11.

In

In the year 1705, there was mentioned in the academy an uncommon appearance of a barometer, that belonged to the lord chancellor, which kept 18 or 19 lines lower than all other barometers, and greatly ſurprized the whole academy; when it was inclined, and the mercury was made to riſe to the top of the tube, it was exactly filled, and not a bubble of air was to be ſeen; from whence it was concluded neceſſarily that the vacuum was perfectly well made, and that there did not remain any air that could keep the mercury lower than it ought to be; and by trying the tube with other mercury as well as by putting that mercury into another tube, it was plain there was no fault in the mercury. Divers opinions were then propoſed in the academy, and the concluſion was that experiments ſhould be made. Mr. Maraldi hath ſince made them, and they all confirm the conjecture of Mr. Homberg, who imagined that the lord chancellor's barometer kept lower than others, becauſe he recollected that before it was filled with mercury it had been waſhed with ſpirit of wine. He ſuppoſed that ſome little drops of the ſpirit of wine had remained, which, when the vacuum was made, being extremely rarefied, had depreſſed the mercury; whether they depreſſed it of themſelves, or whether the air which they contained, being diſengaged by their rarefaction, depreſſed it, he did not determine.

An uncommon phenomenon of the barometer.

By Mr. Maraldi's experiments it appeared that the waſhing the tube with the ſpirit of wine, though it was well wiped afterwards, conſtantly produced this effect. In different experiments the difference of the height varied from 6 to 18 lines.

It is remarkable alſo that by the ſame gentleman's experiments it appeared, that if a tube hath been waſhed with the ſpirit of wine the mercury keeps lower in it, than if the ſame tube had been waſhed with brandy; and if it hath been waſhed with brandy, the mercury keeps lower in it, than in a tube waſhed with water. If, however, the tubes waſhed with theſe different liquors, have been afterwards well wiped and well dryed, the mercury keeps in them at the height it was before they were waſhed. To dry perfectly tubes, that have been waſhed with ſpirit of wine, it is ſufficient to leave them expoſed for ſeveral days to the air, provided that it is not moiſt.

Upon the whole, no other reaſon can be imagined, but that the little drops of liquor, which have moiſtened the inſide of the tube, being rarefied *in vacuo*, or that the air confined in thoſe liquors, being diſengaged from them, cauſe the mercury to ſink. The firſt notion is the leaſt probable; becauſe if the ſpirit of wine by itſelf depreſſed the mercury, it would depreſs it *leſs* than the brandy, ſeeing that it is leſs heavy; and brandy, being

leſs

leſs heavy than water, would depreſs it *leſs* likewiſe; but by Mr. Maraldi's experiments the contrary holds true. It follows, therefore, conformably to the ſecond notion, that there is more air contained in the ſpirit of wine than in the brandy, or that the air diſengages itſelf more eaſily from it; and the ſame muſt hold with regard to brandy compared with water. It is true the difficulty objected to it by the late Mr. Amontons ſtill remains; who oppoſed to this reaſoning, that it was incredible that a few little drops of ſpirit of wine, or of water, extremely rarefied, and of conſequence extremely weakened as to their ſpring, ſhould yet have a force equal to 18 lines of mercury; that by inclining thoſe tubes, where it was ſuppoſed thoſe rarefied ſubſtances were contained, and by making the mercury riſe to the top, they muſt have ſeen thoſe ſame ſubſtances, recondenſed by the weight of the mercury, form bubbles, like to thoſe that air forms, had there remained ever ſo few in the tube; that notwithſtanding nothing like this was ſeen; that in order for air left in the tube to depreſs the mercury 18 lines, there muſt have been left a very conſiderable quantity of it, and entirely diſproportionate to that of the little drops, to which the ſame effect had been attributed. Finally, Mr. Amontons produced two new tubes, that could not be ſuſpected of having been ever waſhed with water or ſpirit of wine,

where

where the mercury kept between 6 and 7 lines lower than in other barometers. Mr. Amontons was of opinion that there entered a ſubtil air through the pores of the tube; and what favoured this hypotheſis of Mr. Amontons was, that having emptied and filled again with mercury the tube, which was the ſubject of all his experiments, he found that after *that* its difference of height from other barometers was diminiſhed an half, and that it was no more than 9 lines lower. He ſuppoſed that the mercury in paſſing had left a kind of very fine filth, which had ſtopped up a part of the pores of the glaſs, or had rendered the paſſage of them more difficult. Several of the academy however did not admit the ſyſtem of Mr. Amontons, which muſt render ſuſpected an infinite number of experiments preceding, in which it had been always ſuppoſed that no glaſs would let any matter, capable of weighing upon mercury, to paſs through it.

What is to be concluded from the whole? Nothing yet. The academy refers the deciſion to experiments yet further to be made, and perhaps it will require a long ſeries of them. The academy doth not deſign to communicate only the hiſtory of her diſcoveries to the public; ſhe thinks that ſhe ought to communicate likewiſe her doubts, and ſhall ſee with extreme ſatisfaction,

tion, that her doubts contribute to the diſcoveries of others.

Hiſtory 1706, *pag.* 1. *and* 1705, *pag.* 16.

The heat of the weather at Paris on the 6th of Auguſt 1705, was ſo great, that there had not been felt any thing equal to it for 36 years paſt. Who would not have thought that in that great heat the burning glaſs (which was that of the duke of Orleans made by Tſchirnhaus) ſhould have had much greater effects than at any other ſeaſon? But the contrary happened; and ſurely ſuch a phenomenon could not have been deviſed upon any ſyſtem. Mr. Homberg found that the rays of the ſun collected by the mirrour had ſcarce any force, whilſt the ſeparate direct rays quite inflamed the air. A curious obſervation on the burning glaſs.

The reaſon he imagines of ſo ſurpriſing a phenomenon is, that the great heat raiſes from the earth an infinite number of ſulphureous exhalations, and that theſe ſubſtances on account of their being homogeneous, according to Mr. Homberg's ſyſtem, with the matter of light, embarraſs, ſtop, and in ſome ſort abſorb the rays; whether it be that they intercept abſolutely a part of them, and hinder them from falling upon the mirrour, or whether they produce with regard to them the ſame effect as a ſcabbard with regard to a ſword, and by that means take from them their extreme ſubtility, ſo neceſſary to cut through

through hard bodies immediately. This conjecture is confirmed by an experiment that Mr. Homberg hath made.

He placed between the mirrour and the focus a chafing-dish full of lighted coal, so that the rays which went to the focus passed through the vapour of this coal, and he found that the mirrour was considerably weakened by it. This was a representation of what happens in excessive hot weather, or rather is the thing itself in miniature. Moreover Mr. Homberg hath always observed, even in moderate and ordinary hot weather, that when the sun hath shone out for several days successively, the effect of the mirrour is not so great, as when it breaks forth immediately after a shower; the reason is that the rain hath precipitated the sulphureous exhalations, and purged the air.

History 1705, *pag.* 39.

A remarkable cure of a delirium by music.

A famous musician, a great composer, was seized with a fever, which having increased daily, became continued; on the 7th day he fell into a very violent delirium accompanied with shrieks, tears, panics, and a perpetual wakefulness, almost without any intermission. On the 3d day of his delirium one of those natural instincts, which it is said make the brute animals when sick to seek the herbs that are proper for them, made him ask to hear a little concert in his chamber.

It

It was with great difficulty that his phyſician conſented to it. From the firſt tunes he heard, his countenance aſſumed a ſerene air, his eyes were no longer wild, the convulſions ceaſed abſolutely, he ſhed tears of pleaſure, and had *then* for muſic a ſenſibility, that he never had before, nor hath any longer now he is recovered. He was free from the fever during the whole concert, and as ſoon as it was finiſhed he relapſed into his former condition. Upon this they did not fail to continue the uſe of a remedy, whoſe ſucceſs had been ſo unforeſeen, and ſo happy; the fever and delirium were always ſuſpended during the concerts, and muſic was become ſo neceſſary to the patient, that at night he made a kinſwoman that waked with him to ſing and even to dance. One night particularly, when he had no body with him but his nurſe, who could ſing nothing but a vile ballad, he was obliged to be content with *that*, and found ſome benefit from it. At length in 10 days, *muſic* had entirely cured him, without any other aid than that of bleeding him in the foot, which was the ſecond time of his being blooded, and was followed by a large evacuation. Mr. Dodart related this hiſtory, into the truth of which he had carefully examined; he did not mean that it could ſerve for an example, or a rule; but it is curious enough to ſee how in a man, whoſe very ſoul, as one may ſay, was become muſic by

a long and continual habitude, concerts had reſtored by degrees to the animal ſpirits their natural courſe. It is not probable that a painter could be cured in like manner by paintings; painting hath not the ſame power as muſic on the motion of the animal ſpirits, and no other art probably can equal it in this point.

Hiſtory 1707, *pag.* 7.

Another. The extraordinary cure we have ſpoke of by muſic is no longer a ſingle inſtance; we have received another example of it from Mr. De Mandajor, mayor of Alais in Languedoc, a man of underſtanding and probity.

A dancing maſter of Alais, having fatigued himſelf during the carnaval of 1708, with the exerciſe of his profeſſion, fell ill in conſequence of it, the beginning of Lent. He was ſeized with a violent fever, and on the 4th or 5th day fell into a lethargy, which laſted a long while. He no ſooner recovered from the lethargy than he fell into a furious, but a mute delirium, in which he made continual efforts to get out of bed, threatened with the motion of his head, and by his looks, thoſe that hindered him from it, and even all thoſe who were preſent; and refuſed obſtinately, but without ſpeaking, all the medicines that were offered to him. It came into the thoughts of Mr. De Mandajor, who ſaw him in that condition, that, perhaps, muſic might

might a little compoſe the imagination that was ſo diſordered, and he propoſed it to the phyſician, who did not diſapprove the notion, but was with reaſon afraid of the ridicule of the preſcription, which would have been infinitely greater ſtill if the patient had died in the operation of ſuch a remedy. A friend of the dancing maſter, who had no reaſon to be under ſuch prudent cautions, and who could play on the violin, took up *that* of the dancing maſter, and played to him on it thoſe airs which were the moſt familiar to him. The by-ſtanders thought the man more mad than he they kept down in his bed, and began to abuſe him; but the patient almoſt immediately ſat up in his bed, like one agreeably ſurpriſed, and wanted to figure with his arms the motions of the tunes: as his arms were held with force, he could only ſhew by the motions of his head the pleaſure that he felt. By degrees, however, thoſe that held his arms finding the effect of the violin, looſened the force with which they held them, and yielded to the motions he wanted to give himſelf, as they perceived his motions were no longer furious. At length in about $\frac{1}{4}$ of an hour he fell into a deep ſleep, and had during that ſleep a criſis which recovered him from all danger.

Hiſtory 1708, *pag.* 22.

A remark on the giving ſuck to children in Batavia.

Mr. Homberg, who was born at Batavia, acquainted the academy that the European women, who go thither, cannot give ſuck *there* to their own children; becauſe their milk is ſo ſaltiſh that the children will not take to it; whereas the milk of the black women, though they uſe the ſame food, is ſweet and ſugary commonly, and therefore the black women give ſuck to the children of the Dutch and Engliſh. He himſelf was ſuckled by a black. The reaſon he imagines to be this, that when the European women remove into a climate ſo hot, for which they are not formed by nature, the veſſels deſtined in them to ſecrete the milk become too much dilated, and let paſs the ſalts which ought not to enter into the compoſition of that liquor: but that the natives of the hot countries are, by their firſt formation, ſuch as they ought to be for breeding a well conditioned milk; either that the veſſels which ſtrain it are naturally more ſtrait, and do not dilate afterwards more than they ought, or that they are of a more firm texture, and leſs capable of dilatation; or laſtly ſomething equivalent.

Hiſtory 1707, *pag.* 10.

The uſefulneſs of ants at Surinam.

Mr. Homberg read a letter dated the 24th of January 1701, which he had received from Paramaribo, in the province of Surinam, on the north coaſt of ſouth America. Paramaribo is a Dutch colony. This letter contained

contained a ſingular remark with regard to natural hiſtory. There are in that country *ants*, which the Portugueſe very juſtly call viſiting ants; they march in troops, and like a great army. As ſoon as they appear, all the coffers, and all the cheſts of drawers in houſes are opened for them, they enter and exterminate rats, mice, cackerlacs, which are a kind of inſects in the country, and all noxious animals, as if they had a particular commiſſion from nature to puniſh them, and rid men of them. If any one was ſo ungrateful as to moleſt them, they would fall upon him and tear in pieces his ſtockings and his ſhoes. The misfortune is that they do not keep, as one may ſay, their days of paying viſits often enough; they would be welcome every month, and they do not appear ſometimes for three years.

Hiſtory 1701, *pag.* 16.

An uncommon meteor in the air.

On the 7th of January, an hour before day light, there appeared to the inhabitants of Hague in lower Normandy, a body of fire ſo bright that it effaced the light of the moon; the inhabitants of St. Germain des Vaux, and of Auderville, two large villages ſituated on the ſea ſhore, thought at firſt it was day light, and were very much ſurprized at ſo prodigious a brightneſs. This fire had the figure of a great tree, and went from weſt north weſt, to eaſt ſouth eaſt. It was more than an hour

day when it fell, and its fall was with ſo great a noiſe that the houſes of thoſe two villages ſhook with it. It was thought by thoſe, that were twelve leagues diſtant, of Cherbourg, that it had fallen upon Valognes, and thoſe of Valognes thought it fell on Cherbourg. But as the inhabitants of Hague only heard the noiſe, and felt the ſhock that its fall occaſioned, they are the moſt credible witneſſes on that point. It appeared to them that this flame fell into the ſea, near the little iſland Origni, and the ſight reſembled *that* of a large ſhip on fire. The academy is obliged for the account of this phenomenon to Mr. De Seneſſey, a gentleman of lower Normandy.

Hiſtory 1700, *pag.* 10.

A remarkable ſtorm of hail with its conſequences.

Mr. Parent gave an account that, on the 15th of May, there fell about Iliers in Perche a prodigious quantity of hail, which was prodigious likewiſe on account of its ſize. The leaſt was as big as the two thumbs, the biggeſt was equal to a fiſt, and weighed a pound $\frac{1}{4}$, and the middle ſize was about the bigneſs of hens eggs, and was the moſt conſiderable in quantity; it fell in ſeveral places a foot in height. The corn of 30 pariſhes was cut as if the ſickle had gone through it. The inhabitants of Iliers, ſeeing the havock, had immediate recourſe to their bells, which they ſounded with ſo much vigour,

gour, that the cloud rent aſunder over their pariſh, and the broken ends ſeparated from each other, inſomuch that that pariſh alone amidſt 30 others, which had not ſuch good bells, hath received but little damage. Mr. Parent added to the account, that as the corn at that time was but little advanced, though for the moſt part in ear, it threw up again a new blade, and thoſe blades began to ſhoot forth little ears, which it was hoped might come to maturity. He hath *ſince* heard that the crop was good.

Hiſtory 1703, *pag.* 19.

N. B. *This account is the more remarkable as in a deſcription of the like miſchief by hail at Hitchin in Hartfordſhire, on the 4th of May in the philoſophical tranſactions it is ſaid,* " It cut down great fields of " rye as with a ſcyth, and has deſtroyed " ſeveral hundred acres of wheat, bar- " ley, *&c.* in ſo much that they plough " it up, and ſow it with oates."

Vid. Lowthorp's abridgement, vol. 2d, pag. 147.

A curious petrified bee-hive.

Mr. Dodart having received from Mr. Lippi, a licentiate of the faculty of phyſic at Paris, a letter dated from Siout, in the upper Egypt, the 5th of September 1704, and which contained a ſingular fact, communicated it to the company.

Mr. Lippi found upon the mountains of Siout, at the entrance of a vaſt cave, a body that was truly ſtone, of an irregular figure, but intirely porous, which he had the curioſity to open. He was very much ſurprized to ſee it all divided into oval cells, of 3 lines in breadth and 4 in length, placed in all directions, with regard to one another, no ways communicating with each other, lined all on the inſide with a very delicate membrane; and, what is the moſt marvellous, containing *each* either a worm, or a maggot, or a fly perfectly reſembling a bee. The worms were very hard and ſolid, and might be conſidered as petrified; neither the maggots, nor flies were *ſo*, but only dried and well preſerved like ancient mummies. The flies had in many places under them little oval grains, which ſeemed to be eggs. There was at the bottom of abundance of cells a thick, blackiſh, and very hardened juice, which appeared red when held up againſt the light, was very ſweet, made the ſaliva yellow, and burned like roſin. In a word it was true honey.

Mr. Lippi conceived that it was a natural bee-hive, which had been at firſt formed of an earth looſe, light, and ſandy, and which had been afterwards petrified by ſome particular accident. The animals that inhabited it had been ſurprized by the petrification, and as it were fixed in the ſtate wherein they were found,

found. Their mucilage which became dry had formed the membrane that lined the cells: at the time that the hive was yet ſoft the worms and the flies went out to get their food, and the flies *there* made their honey.

Looking about in the ſame place for new lights on this fact, Mr. Lippi found in ſeveral places the beginnings of a like hive.

Hiſtory 1705, *pag.* 36.

Petrified fiſh.

Mr. Maraldi brought from Italy ſome hard ſtones of a whitiſh colour, that ſplit into leaves, in which are found fiſh dried, ſtraws, and leaves of the olive tree; they were found near Verona by Mr. Bianchi, knight. It happened luckily that in ſplitting the greateſt part of thoſe that contained a petrified fiſh, they ſplit exactly in half, in ſo much that the two parts are eaſily diſtinguiſhable. It looks as if they had been imprinted in a kind of mould. All the external parts of the body of the animal are very exactly marked, and there is no room to doubt but that they are real fiſh, enveloped by a ſand that afterwards petrified.

Mr. Maraldi hath ſeen in the gallery of the Great Duke the like fiſh dried in ſtones, that had been taken in Phenicia, in the territory of the town of Biblis, called at preſent Gibeal, upon mountains almoſt inacceſſible, and 15 miles diſtant from the ſea.

He

He hath ſeen likewiſe at Rome ſeveral great pieces of marble, mixed with red and white, which were brought from mountains in Sicily. What forms the white is a great quantity of ſhells included and incorporated into the marble.

Hiſtory 1703, *pag.* 22.

Of petrification and origin of ſtones.

With regard to the production of ſtones, we have nothing known with more certainty than the origin of thoſe cryſtalline congelations, that hang ſometimes from the vault of ſubterraneous grots, ſometimes line the ſide walls, and ſometimes cover the floor. You may almoſt follow with your eye their growth; at leaſt it is inconteſtable that it is owing to the little ſolid parts which a liquid continually depoſits. The aſſemblage of theſe little parts, depoſited one upon another, forms *in time* lumps which are our cryſtalline ſtones. We ſhall make no difficulty of calling by the terms *lapidific juice*, or *ſtony juice*, that water which is loaded with the matter proper for the formation of this kind of ſtone and of all others. Theſe terms thus explained cannot be equivocal. It is of no moment whether the matter with which this water is loaded be called *ſtony matter*, or whether it be called *cryſtalline matter*, as Mr. Geoffroy would have it: this laſt term however appears to me, ſays Mr. Reaumur, extremely proper, and to give a more preciſe idea than

that

that of *ſtony matter*. But this matter that forms cryſtals, what is it? I conſider it, ſays Mr. Reaumur, as an extremely fine ſand, which is *ſo* to ſuch a degree, as to be eaſily ſupported in water. Groſs art, by pounding emeril, puts it in a condition for remaining ſeveral days in common water without ſinking to the bottom. Nature may go ſtill further; the ſand that the water detaches from hard ſtones by mere rubbing is probably of an inconceivable fineneſs: indeed art goes as far, perhaps, as we have need to make nature go in this buſineſs, ſince by mere beating it reduceth gold to ſwim in water, to be ſupported in it as if it was diſſolved, and to be in a condition to paſs with it through refining paper.

The lapidific, or ſtony juice, forms cryſtalliſations, cryſtals, and all the tranſparent ſtones, when the ſolid parts that it carrys along with it faſten immediately one to another; the ſame juice forms ſtones with grains and common ſtones, when it depoſits thoſe ſolid parts amidſt ſand and gravel, between mixtures of ſand, gravel, and talc, or laſtly amidſt gravelly earths: it compacts the parts of thoſe different materials ſo as to make an entire ſolid maſs; from thence come brown free-ſtones, granates, common ſtones, and an infinite number of other ſorts of ſtones that are between the preceding ſorts. But I conceive that the ſame juice forms flint ſtones by petrifying ſtones a ſecond time, if I may be

be allowed the expreſſion, or by petrifying the more compact earths; I mean that the ſtones already formed, but ſpungy after their firſt formation, become flints, if they are penetrated anew, and to a certain point, by the ſtony juice. In like manner clays, chalks, marls, boles, and all the compact earths, being penetrated by the cryſtalline or ſtony juice, become flints. I compare the three claſſes of ſtones, of which I have been ſpeaking, to three ſorts of vitrified ſubſtances, or that have begun to vitrify, which art repreſents to us in common potters ware, china ware, and glaſs. As theſe three ſorts of ſubſtances differ from each other chiefly in their different degrees of vitrification, becauſe they have each more or leſs of vitrified matter; in like manner the claſs of ſtones with grains and common ſtones, that of flints, and that of cryſtals, differ in the quantity of cryſtalline matter that they have received from the ſtony juice: flints are with reſpect to the two other claſſes of ſtones, what china ware is with reſpect to glaſs, and to common potters ware.

But to explain more fully my notion on the origin of flints, let us apply it to an example that may be converted into a proof. I confine myſelf to a piece of common ſtone, ſuch as lime ſtone, or building ſtone; theſe ſtones are naturally ſpungy, at leaſt they were ſo before they were drawn out of the womb

of

of the earth; they are eaſily ſteeped in water, in their bed they are fully ſoaked with it; but we muſt not imagine that it is always the *ſame* water that lodges there; the water is ſtrained through theſe ſtones; what drops continually from vaults, or roofs, of abundance of quarrys is a proof of it. Let us ſuppoſe that the water, which enters into theſe ſtones, and muſt paſs through them, is loaded with a cryſtalline matter which is extremely fine. If this water arrives to a certain part of the ſtone, and there depoſits the ſolid particles it hath brought with it; theſe little parts will by inſenſible degrees fill the vacuities that are between the grains of the ſtone, and at length entirely ſtop them up. This ſtone from being ſpungy, as it was before, will become almoſt impenetrable by water; the vacuities which were between its little lumps being filled, and thoſe lumps connected to the little ſtony grains that have formed themſelves between them, the ſtone will become harder, it will no longer have any perceptible grains, and its broken fragments will always have a poliſh, which is one of the principal characteriſtics of a flint ſtone: it will likewiſe at the ſame time have acquired tranſparency, becauſe the matter, which *now* occupies the intervals that were between the former lumps, is of a denſity more nearly approaching to *that* of the matter of the lumps, than was that matter which occupied *before* the

ſame

ſame intervals, *namely*, than air. In a word, this ſtone will have become a true flint. If it is taken out of the quarry before the water hath depoſited a ſufficient quantity, it will be found *more* a flint in ſome places than in others; that place, where the juice firſt ſtagnated, and where all the paſſages have been the ſooneſt ſtopped up, becomes the ground or foundation of the whole. According as the water ſhall have had more eaſe in paſſing and depoſiting in certain directions, there will be found veins *more* flintiſh than the reſt, other places will be found where there are only the beginnings of a flint.

To ſhew that what we have been deſcribing is not a mere imagination; and to give examples of ſtones, where all ſeems to have paſſed as we have mentioned, you need only go along the wall of the new encloſure of the park of Vincennes, which is by the road-ſide to St. Maur. In this wall, which is more than half a league in length, you will find at each ſtep ſtones, of which one part is common ſtone, and the reſt flint. I have obſerved theſe ſtones with great attention, am perſuaded that I have diſcerned in ſeveral the different ſtates through which they have paſſed, in order to become flints, and am ſatisfied of ſeeing *there* flints of different ages and different degrees of perfection.

But it is not ſtones alone that may become flints; all the compact earths, ſuch as marls are,

are, chalks, boles, and very close clays, will be transformed into this sort of stone, as soon as their little clusters shall be penetrated and connected together by the stony juice.

All clay however is not changed into flint as soon as it becomes stone. There is a clay that is not sufficiently compact, whose parts are not close enough one to another: this clay may take in time the consistence of common stone, and afterwards become flint.

I have some round flints that would be taken for pieces of clay, if you observed only their surface; they have *there* precisely the colour of gray clay; and indeed this surface, and their first coat, are, strictly speaking, still earth, they may be diluted with water: beneath this first coat they preserve the colour of clay, but by touching them, and by rubbing them, you are assured that they are stones. Lastly, the more you advance internally the more you find them to be stones, the more you discover in them the essential character of flints, namely, the smooth breaking, and *being* without grains; there is wanting nothing to them but a little transparency.

When clay and the other compact earths are dryed, they chap, they split asunder; these chaps, which are in a straight line, cross one another in a thousand irregular manners, and form infinite sorts of figures, that have not any regularity, but are constantly included in straight lines. If you hold up

agates

agates to the light of the ſun, to the light of a candle, or to broad day light, you will often diſcover within them figures reſembling thoſe of chapped clay: this is more common in oriental agates than in others. Mr. De la Faye ſhewed theſe ſorts of figures to the academy in 1716. It always appeared to me that theſe figures could not be better accounted for than by ſuppoſing that the juice, which had hardened theſe ſtones, had for its baſis chapped clays, and Mr. De la Faye at that time was pleaſed to adopt my opinion. The chinks formed by thoſe chaps were, like the reſt, filled by a cryſtalline juice; but the chinks, tho' exactly filled, yet being *ſo* by more of the cryſtalline matter, and leſs of earthy matter, have a tranſparency different from *that* of other places, and this difference of tranſparency ſufficeth for tracing within agates thoſe figures, of which we have been ſpeaking.

It is to a ſtony juice, a cryſtalline juice, to a juice of the ſame nature as that which forms cryſtalline congelations, that we have attributed the change of ſtones and compact earths into flints; almoſt all thoſe flints in which are found void cavities, however ſmall they may be, appear to furniſh ſolid proofs of this opinion. Let us obſerve *theſe* cavities, you will almoſt always ſee cryſtals in them; now it is by no means probable that the matter which hath formed theſe cryſtals hath penetrated

netrated the flint ſince it is become a flint. The cryſtalline juice, the ſtony juice, is conveyed by a common water, in which it floats; now the ſubſtance of flint is ſcarce penetrable by water; even when it is in its bed, it is always found there with a ſolidity and hardneſs approaching to what it hath above ground: it is therefore more probable that the matter, which hath formed the cryſtals, traverſed the flint whilſt it was yet only common ſtone, or compact earth.

When the ſolid parts of this juice have without any thing intervening catched and faſtened one to another, they form in the midſt of common ſtone *tranſparent ſtones*, ſuch as they form in the vaults of ſubterraneous caverns; we may conſider each *hollow* ſtone, whilſt it is in its bed, as a little ſubterraneous grotto.

There are ſome flints that have only veins of cryſtalline matter; ſuch are *thoſe* which we find at the top of Champigny, near St. Maur: beſides the cryſtalline veins which are rare in them, they have veins of all ſorts of colours, which have ſo pretty an effect that we cannot forbear mentioning, by the way, that they deſerve at leaſt as much to be wrought, as many of thoſe flints which we get from afar.

But ſome other flints are, as we have ſaid, ſubterraneous grottos; they contain cavities very conſiderable with reſpect to their ſize;

the ſides of theſe cavities are covered ſometimes with white cryſtals, and ſometimes with coloured cryſtals. Provence furniſhes us with ſome where theſe cryſtals are amethyſts. Other flints, ſuch as are thoſe of Orel, and St. Die in Dauphiny, contain in the middle of their ſubſtance cryſtals diſperſed here and there. But it is to be remarked always that all about thoſe diſperſed cryſtals there are a kind of crevices, ſometimes more, and ſometimes leſs conſiderable, which ſeem to owe their origin to chaps made in the earth; and indeed theſe laſt mentioned flints are of that kind, which we ſaid before have a clay colour, and have ſtill a coat of that ſort of earth. It doth not follow however that all the ſtones, which have cavities where cryſtals are contained, muſt be flints; I have ſome ſtones from Berry very like to common ſtones, to the ſides of whoſe cavities are attached very white cryſtals.

The cryſtals are formed before the ſtone begins to be changed into flint; if a ſtone be taken from the quarry before the cryſtals have grown *there* as much as they could grow, the ſtone will not be yet flint, the juice that hath traverſed it having been employed in the formation of the cryſtals.

There are curious perſons that preſerve flints, on whoſe broken pieces appear traced ſome ſingular figures, ſuch as the bodies of animals,

animals, heads of men, &c. Theſe figures owe their origin only to a particular diſpoſition that happened to be in the arrangement of the cracks; amidſt ſome thouſands of broken flints there are a few, where theſe remarkable arrangements are found, and they are *thoſe* which are collected into cabinets.

Memoirs 1721, *pag.* 257.

Of the roundneſs of ſtones.

There was wanting to the ſyſtem of the formation of ſtones, given by Mr. De Reaumur in 1721, an explication of the roundneſs affected by certain ſorts of ſtones, and principally by flints; we do not mean a perfect roundneſs, nor any thing approaching to it, for that is very uncommon, but a general groſs roundneſs.

The new lights, which we mentioned in 1721 it was better to wait for on this ſubject, have come and offered *themſelves* almoſt to Mr. De Reaumur.

In a bank of ſand, dug near his country houſe at Charenton, he found a great quantity of little heaps of this ſame ſand diſtinguiſhed from the reſt by being connected, more compact, and almoſt all irregularly rounded: he calls them knots of ſand in imitation of workmen who call knots of clay the like bodies which they find in clay. * Theſe knots of ſand were of all ſorts of ſizes, from that of a pea to that of a man's head, and

* The technical term in French is marrons, cheſnuts.

ſometimes larger. Several, and particularly the larger, had but one external covering of ſand, within which they were ſtone, and already flint in the center. The general colour of the bank of ſand was greeniſh, it changed in the knots according to the degree of their transformation, it grew brighter and whitened when they were ſtone, and burniſhed when they were flint; the ſtony juice, of which we have ſpoke, was *here* throughout the whole diſcoverable. What compleats the proof is, that above this bank of ſand there was another of a more groſs and dry ſand, quite full of flints well formed and perfect, of an infinity of different figures, and all whoſe figures had their *fellows* in ſome knot of the lower bank; theſe knots therefore were deſtined to become flints.

If the ſtony juice, whenceſoever it comes, or whatſoever courſe it takes, finds a bank of ſand, where it can flow and diffuſe itſelf equally on all ſides, and in all directions, it will equally connect all the grains of ſand, and make of them a *whole*, which will be one maſs or bank of brown free ſtone; but what will moſt commonly hinder this exact uniformity, is, that the grains of the ſand-bank will not be always regularly enough diſpoſed with reſpect to one another, a thouſand accidents will have made them cloſer in ſome places than in others, will have ſeparated them into different heaps, have cauſed

pretty

pretty large interſtices, particularly if the bank is not of pure ſand, but mixed with earth, as is common; the ſtony juice will *then* have in this bank of ſand an unequal courſe, ſometimes more, ſometimes leſs eaſy: and as this juice, according to Mr. Reaumur, is only a ſand, which is prodigiouſly fine, conveyed in water, that ſupports it whilſt the water hath its whole motion, and doth not let it fall till that motion is checked, it follows that it will not be depoſited but in places where the water will meet with ſome obſtacles; that is, in thoſe places where it will be ſtopped by the heaps of ſand, and by the knots.

The water that is ſtopped by a knot, of whatever figure it be, divides itſelf in order to flow round from the moſt elevated point of that body to the diametrically oppoſite loweſt point; and this it doth becauſe *this* water being more viſcous than any other is on that account more diſpoſed to follow the windings of theſe bodies; by this movement it neceſſarily makes the knot as round as it is poſſible to be, and flattens the pointed angles of it.

Suppoſing that we are in the right track with regard to the formation of ſtones and flints, we may go on to *that* of metals; analogy will lead us far; we need only conceive a water loaded with metalline juices, inſtead of ſtony juices, and give this water ſuitable earths that it may pervade: the roundneſs of

the metalline grains will be explained by the principles already eſtabliſhed. But the beſt grounded hopes ought only to encourage us to make diſcoveries, and not to make us believe that we have already diſcovered.

Hiſtory 1723, *pag.* 9.

The preceeding theory confirmed by an experiment of artifical ſtone.

Mr. Baſin, a correſpondent of the academy at Straſbourg, was willing to try if by following the notions of Mr. De Reaumur he could make an artificial flint.

At the end of the year 1734, he took ſome potters earth quite prepared for making kitchen earthen ware; the piece was of the bigneſs of two fiſts, he ſteeped it in a good deal of water, and took great care that there ſhould be no gravel in it, or little ſtone, but only a pulverized earth; he put it into a varniſhed earthen diſh, which he expoſed on the outſide of a window to the north.

During the courſe of the two years 1735, and 1736, Mr. Baſin watered this earth almoſt regularly every day with water from a well, which he judged more proper than any other for his deſign, becauſe having been filtrated through the ground it muſt be loaded with more of the ſtony juice. In 1737, and all 1738, he ceaſed watering his earth, and in the beginning of 1739, a ſpace of time ſhort enough for ſuch an enquiry, he was willing to ſee whether any thing had happened.

The

The event ſhewed that he had not been entirely too impatient. He perceived at the bottom of the veſſel an hard body, which he could not ſeparate with his knife as he had the reſt, and it was found to be a true ſtone, as big as an haſel nut, and which he could not break with an hammer, but by employing as much force as would be neceſſary for beating down the head of a little nail.

Hiſtory 1739, *pag.* 1.

Obſervation on flint quarries.

The pariſhes of Meunes and Couſſy in the territory of Berry, two leagues diſtant from St. Aignan, are the places which produce the beſt flints for a gun in all France, and almoſt the only good ones; and indeed they not only furniſh France, but very often foreign countries; they have been taken from thence without intermiſſion for a long time, perhaps ever ſince the invention of gun-powder, and yet this diſtrict is very ſmall. However flints never fail there, as ſoon as a quarry is emptied it is ſhut up, and ſeveral years after they find flints there as before.

Hiſtory 1738, *pag.* 38.

Of the progreſſive motion of ſeveral ſorts of ſhell fiſh.

Almoſt all the modern authors, who have treated hitherto of the natural hiſtory of ſhell fiſh, have confined themſelves to give deſcriptions and deſigns of their ſhells: thoſe *caſes*, if I may be permitted the uſe of that term, in which are incloſed divers ſpecies of

ſea animals, greatly merited in truth the pains that have been employed, both on account of their ſingular ſtructure, and for the prodigious variety that there is amongſt them; but the animals which they contain were well worthy in their turn of a like attention.

It is true that we have not an equal facility in examining the animals and their ſhells, the greateſt part of which having been collected into the cabinets of the curious could there be pryed into at leiſure and without difficulty; whereas whatever is ſingular in the animals, that they cover, could only be perceived by thoſe who are reſolute in putting their patience to long and tedious trials, when their view is to diſcover the marvels, which nature ſeems to have taken a pleaſure in concealing from us. It is not ſufficient to go and ſearch for them on the ſea ſhore, you muſt ſit and watch *there* with diligence for the favourable moments in which they ſhew us by different actions that they are perfect animals, you muſt even contrive means to determine them to execute thoſe different actions in *certain* circumſtances, wherein you may more eaſily obſerve them.

The voyages, ſays Mr. De Reaumur, which I made ſome years *ſince* on the coaſts of Poitou and Aunis, gave me convenient opportunities of examining theſe animals very attentively.

Of the ſea muſcles.

The ſea muſcles being faſtened to ſtones, or to one another, by ſeveral kinds of threads, one would not think that they could have any progreſſive motion; yet they are able to move, and in order to prove the fact by a ſingle inſtance, I need only relate the following well known truth.

At the time the weather becomes too cold to get ſalt out of the ſalt pits, the fiſhermen throw into theſe pits ſome muſcles which they have taken on the ſea ſhore; they have a notion that the fleſh is made more delicate by keeping the animal in a water that is leſs ſaltiſh, for the rain water that falls into theſe pits, to which they leave at that time no communication with the ſea, makes the ſalt water of the pits more freſh by mixing with it. I ſhall juſt mention by the way, that it is by the ſame means the fleſh of oyſters is rendered green: the fiſhermen throw the muſcles into theſe pits ſeparated one from another, and at different diſtances, and when they go to fiſh for them afterwards they find them collected into large parcels. Now it is evident that the muſcles could not have approached one to another to faſten *thus* without moving themſelves, for they are not in a running water. This fact is ſufficient therefore to eſtabliſh their progreſſive motion.

We muſt now enquire what part they employ for this purpoſe: to be ſatisfied of this you need only open the ſhell of a muſcle on the

the ſide it naturally opens at; nothing appears in the body of the animal more diſtinct than a certain black or brown part, the baſis of which is placed pretty near the middle of the other parts, and whoſe point is turned towards the ſummit of the ſhell; its length is about 6 or 7 lines. You may form to yourſelf a pretty exact image of its figure, by conceiving that of the tongue of an animal.

Vid. plate 1ſt, fig. 1ſt, L.

Now this is the part which we may conſider as the leg of the muſcle, were it not that a ſhape ſo different from a leg forbids us to apply the ſame name to a *thing* that ſerves however for the ſame uſes, or we may perhaps with more propriety call it the arm of the muſcle, ſince muſcles by means of it rather draw themſelves along than walk.

It would have been impoſſible for me to have diſcovered that this part performs the function I have been attributing to it, if I had obſerved muſcles only on the ſea ſhore; they are never to be ſeen there but when the ſea hath left them on the ſand during the ebb of the tide, and at that time they appear always unactive. In order to obſerve with eaſe in what manner they make uſe of this part, I ordered ſome muſcles to be carried to my houſe as ſoon as they were taken out of the ſea, and I put them in veſſels, into which I poured ſea water enough to cover them, but not enough to conceal them from my

my ſight; as they were then in ſome meaſure in their natural element, they let me ſee a part of the motions that they uſe in the ſea: this is the general expedient I have employed in order to perceive all that I ſhall hereafter relate of the other ſpecies of ſhell fiſh.

I ſaw that when the muſcle is preparing to change its place, it begins with opening a little way its ſhell: it is of no moment which ſide it reſts on; and a little while after that the ſhell hath peeped open, you ſee appear on its edges the point of that part which we have ſaid reſembles a tongue; the muſcle doth not long confine it there, but gives it ſoon a greater extent, advancing it beyond the edges of the ſhell ſhe lengthens it out ſometimes to an inch and half from the edges, but often leſs. When ſhe hath thus changed its figure, by increaſing ſo conſiderably its length, ſhe makes uſe of it to feel to the right and left, before and behind, as if in order to examine the ground about her, and to diſcover on which ſide it will be moſt eaſy for her to advance. All theſe preparations being finiſhed ſhe ſeems determined to make her motion, at leaſt you ſee her bend the extremity of that part which is fleſhy, and very flexible, upon ſome body in order to graſp it; then contracting this ſame part to pretty near its natural extent, without letting it quit the body on which ſhe hath bent its point, ſhe

Vid. fig. 2d.

ſhe obligeth her ſhell to advance towards that body.

Thus you ſee that the contrivance, which muſcles make uſe of in their progreſſive motion, reſembles very much *that* of a man, who lying on his belly would draw near to ſome place by uſing only his arm; he would advance his arm to the moſt diſtant body that he could ſeize with his hand, and then ſhortening the arm would oblige his body to quit its place, as the muſcles quit theirs. All the difference there is between the uſe which the man makes of his arm in the preceding circumſtance, and *that* which the muſcle makes of this part, is that the muſcle truly ſhortens it, whereas the man would only bend the arm.

Muſcles do not often take advantage of the facility they have of moving, for they are commonly all attached one to another, or to other bodies, by divers threads; and it is only when theſe threads are broken, that it happens to them ſometimes to have occaſion to make uſe of that kind of arm. Theſe threads we ſhall now deſcribe.

From the root of that kind of tongue, or from the place where it is attached to the body of the animal, there iſſues a great number of threads, which being fixed on neighbouring bodies keep the muſcle faſtened to them. Each of theſe threads is pretty near as big as a large hair, or an hog's briſtle; they

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are commonly in length from one inch to two; they come out of the ſhell on the ſide where it naturally opens; they are faſtened by their extremity on the bodies that ſurround the muſcle, on ſtones for example, on fragments of ſhells, and moſt commonly on the ſhells of other muſcles: theſe threads are as remote the one from the other, as their length and number will permit; ſome are on the ſide of the ſummit of the ſhell, others are on the ſide of the baſis, ſome to the right, and others to the left: I have ſometimes counted more than an hundred and fifty employed in faſtening one ſingle muſcle. Theſe threads are like ſo many little cables, which drawing each to their ſide hold as one may ſay the muſcle at anchor. Vid. fig. 3d.

It ſeemed to me a matter worthy of inquiry, whether theſe threads were a kind of natural hair to the muſcle, which grew with it, and neceſſarily faſtened it, or whether the muſcle had a power of faſtening itſelf by means of theſe threads.

A very plain experiment taught me that in caſe the muſcles were not ſufficiently attached from the firſt, or that their threads were ſeparated from the bodies where they were faſtened, they could faſten themſelves anew to the like kind of bodies.

After having detached divers muſcles one from another, and from the ſtones to which they were adherent; I ſhut them up in trunks

that

that were covered, and put them into the ſea. I examined theſe muſcles ſome days after, and found ſome of them faſtened only to the ſides of the veſſels, others faſtened both to their ſides, and to the ſhells of muſcles, by the threads we have ſpoke of before.

This experiment which ſatisfied a part of my curioſity, increaſed it at the ſame time: I wanted to know what contrivance they had for faſtening themſelves by theſe threads, how the threads could glue them at their extremity, or whether the extremity, which was much bigger than the reſt, might not be conſidered as a kind of hand, of which the reſt of the thread was as it were the arm.

I obſerved theſe threads when they were but freſhly faſtened, and remarked that they were more white, and in ſome meaſure more tranſparent and brilliant than before: this difference gave riſe to a notion, and divers other circumſtances confirmed it, which was that the threads, with which the muſcles had faſtened themſelves, were not the ſame threads as I had left them; that nature perhaps had taught ſome animals of the ſea to *ſpin*, as ſhe has taught *it* to divers animals of the land: in a word that muſcles were perhaps in the one element what ſilk-worms, caterpillers, and ſpiders, are in the other. This conjecture, bold as it was, did not appear to me to want probability; if it had not enough to perſuade me of the truth of ſo extraordinary

traordinary a fact, yet it had enough to make me try experiments proper to inform me.

The aim of my purpoſed experiments was to ſee whether a muſcle, ſtripped of its old threads, would faſten itſelf in a little time after: for in caſe it faſtened, it muſt neceſſarily have ſpun new threads. But as there would be danger, in tearing off the maſs of old threads, that ſome part neceſſary for the forming of new might be injured, I made uſe of the following expedient; after having opened the ſhell of a muſcle a little way, ſo far as it might be opened without ſtraining the muſcular fibres, I introduced a pair of ciſſars, with which I cut the whole bundle, or tuft of threads. This precaution having been taken, it is evident that I had nothing elſe to do but to obſerve whether theſe muſcles thus ſtripped of their threads would attach themſelves as ſoon as *thoſe* to whom I had left them, and at as great diſtances; this I ſaw with pleaſure happen ſome hours after; there were about as many of the muſcles that I had treated in this manner, which faſtened to the veſſels, as there were of thoſe from whom I had not taken a thread; nor did the one attach themſelves at a greater diſtance than the other; I could no longer doubt therefore but the ſea had ſpinſters in muſcles, as the land has in caterpillers and ſpiders.

The part which ſerves for ſo ſingular an uſe well deſerves ſome attention; we have

hitherto only conſidered it under the groſs image of a tongue; we muſt at preſent examine it more cloſely; we have ſhewn before that it is the leg or arm of the muſcle, which it makes uſe of, when unfaſtened from its hold by ſome accident, in order to move: but we are no longer to conſider it as an arm or a leg; it rarely performs their functions; we muſt conſider it now as a wire-drawing inſtrument.

To make it the better underſtood we ſhall obſerve firſt, that though in the greateſt part of its extent it is flat like a tongue, yet towards its origin, or root, it is round like a cylinder, and that it has there leſs diameter than elſewhere. Its other extremity, or its point, is made pretty much like the point of a tongue. From its origin, quite to near its point, you ſee a ſeam or rather a ſlit that penetrates pretty far into the ſubſtance of this part, and divides it length-ways into two equal parts. This ſlit is a real duct, and it is in this duct that the liquor paſſes which forms the threads. Externally it appears only a ſeam or little ſlit, becauſe the two ſuperior edges of this duct are a kind of lips, applied one againſt the other: you ſee eaſily that it is hollow, that it hath ſome depth, and though commonly cloſed, the muſcle hath a power to open it; we ſhall mention preſently in what circumſtances ſhe doth it. Fibres pretty nearly circular are diſpoſed obliquely acroſs the

Vid. fig. 4th, A.

Vid. fig. 4th, F. I.

the duct throughout its whole length, they ſerve without doubt for opening it. The duct doth not reach quite to the point of what we have called before the wire-drawing part; where the duct ceaſeth the tranſverſe fibres ceaſe alſo, and the part hath leſs thickneſs; but it reaches quite to the baſis of the part at the place where it takes a cylindrical figure. This cylinder is an hollow tube, into which the duct opens; and this hollow tube is probably the reſervoir in which is collected the liquor that forms afterwards the threads: it is ſurrounded by divers glandulous parts, proper for ſtraining a gluiſh liquor. The muſcle like the greateſt part of the ſea animals abounds with this ſort of matter; if you apply a finger on what I call the wire-drawing part, and particularly on its baſis, and then draw it away gently, you will draw out divers viſcous filaments, ſuch as are drawn from ſpiders, ſilk-worms, and caterpillers.

We ſhall now with eaſe explain the ſeveral motions of the muſcle which we obſerved when ſhe faſtened herſelf, and may conceive thoſe ſhe conceals from our ſight: ſhe begins probably with compreſſing the glandulous parts, which contain the gluiſh juice proper for forming threads. This juice being ſqueezed out of the parts, that contained it, diſcharges itſelf into the reſervoir that is at the baſis; from thence the muſcle forces ſome into the duct that runs along the whole Vid. fig. 5th, K.

length of the part; the duct being then closed will not permit any effusion. It is without doubt in order to convey it thither that the muscle alternately stretches out, and draws back, its wire-drawing part a great number of times.

The liquor being conveyed quite to the end of the duct, forms a viscous thread; the muscle then applies the tip of its wire-drawer to the body she has chosen, she leaves it there some time at rest, and during that time the viscous thread acquires a consistence, and fastens by its extremity: there remains now only for the muscle to make the thread run out easy from the wire-drawer; and this she does by means of the circular fibres we spoke of, which serve to open the duct through its whole length; the duct being opened, the muscle has nothing to do but to remove her wire-drawer from the thread. This you see her do with great quickness; she draws back the wire-drawing part almost parallel to the new formed thread, and returns it into her shell.

In order to observe all the contrivances, that I have been mentioning, I have often put muscles into glasses full of sea water; the transparency of the glass and water let me perceive the slightest motions. By this means likewise I have seen that the viscous matter, of which they form their threads, takes hold of the most polished bodies; for those threads, that

that they faſtened upon glaſs, held *there* as ſtrongly as what they faſtened upon wood or ſtones.

It ſometimes happens that the muſcle ſtrengthens her firſt threads by additional threads, attached to the neighbouring bodies. Whether it be that thoſe threads have been roped too weak, and have broke when ſhe would have given them play from her wire-drawing part; or whether the liquor was not in a ſufficiently continued ſtream through the length of the duct; whatever be the reaſon, it appears that ſhe is well acquainted that her work may fail in that part; for as ſoon as ſhe hath roped a thread, and brought back her wire-drawing part into her ſhell, ſhe draws herſelf upon this new thread, advancing forward as ſhe draws, as if ſhe had a mind to try if it was good and well faſtened.

The threads that they have roped, when brought home to my houſe, have been commonly more fine, and always more white than the old; the colour probably was owing to their freſhneſs; and that they were more fine may be owing in ſome meaſure to their having been formed in haſte, and at a time when the muſcles had not an abundant proviſion of viſcous matter; at leaſt it ſeems to me very certain that this liquor is eaſily exhauſted. I never ſaw a muſcle that made more than 4 or 5 threads in a day.

I never could diſcover whether they could break *at pleaſure* the cords that they have formed for themſelves: I know that there are many found *detached*, which have large bundles of threads; but divers accidents might have occaſioned *this*, without any contrivance of the muſcles; and the following experiment ſeems to prove that they have not the power of unfaſtening themſelves.

After having let ſome muſcles faſten to the ſides of a veſſel, full of ſea water, I drew off the water in ſuch a manner that ſome were entirely deprived of it, and that others but juſt touched the water with the edge of their ſhell. They were then in a violent ſituation; if there had been any art in them of unfaſtening themſelves, this was the time for making uſe of it, in order to get into the fluid ſo neceſſary for them; yet I perceived no one attempt to break the threads that held him.

Moreover how young ſoever they may be they are able to ſpin: I have often times obſerved ſome that were ſmaller than grains of millet, which formed threads, very ſhort indeed, and of a fineneſs equal to that of the ſilk worms. And indeed the ſmalleſt are collected in parcels as well as the largeſt. In proportion as they grow they have need of ſtronger threads to hold them; the old which are become too ſlender will break of themſelves; and very often the old are broken even though they are big, whether it be that they

they become corrupt as they grow old, or that repeated ſhocks have broke them.

Although the art of ſpinning be an art that is common to muſcles, and to divers terreſtrial animals; yet what we have related ſufficiently ſhews that the mechaniſm they employ in it is particular to them. Worms, caterpillers, and ſpiders, draw from their body threads as long as they pleaſe, by making them paſs through a wire-drawing hole; their proceſs reſembles that of gold wire-drawers: the *proceſs* of muſcles on the contrary reſembles *that* of workmen, who caſt metals in a mould. Their duct is a mould where the thread takes its figure, and a determined length: perhaps too like worms, ſpiders, and caterpillers, they work only in certain months of the year: at leaſt thoſe which I incloſed in veſſels during the months of July, Auguſt, and September, have ſpun; but I never ſaw any threads formed by thoſe which I put into the like veſſels during the month of October; I have found however ſome that have ſpun during this laſt month in the ſea.

Memoirs 1710, *pag.* 439, *and Memoirs* 1711, *pag.* 115.

Of river muſcles.

Mr. Poupart obſerves that the ſtructure of theſe muſcles is ſuch, that one would not have thought they ſhould have any other motion than what they receive from the agita-

tion of the water; yet they all move, and ſome even bound and vault upon the ſurface of the water. The manner of their moving is thus:

Lying on the flat ſide of their ſhells, they advance out a part in ſhape of a tongue, with which they make little motions to the right and left, in order to hollow the ſand or clay of the rivers. By making it hollow *thus*, they incline by degrees ſide-ways, and get upon the edge of their ſhells, the back being uppermoſt; they advance forth afterwards by little and little their head for a minute or two, and then reſt it in order to draw their ſhells to them, in the ſame manner as water ſnails ſometimes do. They repeat this motion as long as they have a mind to move, and in this manner they make irregular tracks, which are ſometimes three or four ells long, and in which they are half hid.

You ſee in the ſummer time ſeveral of theſe tracks in the rivers, where there are many muſcles, and you never fail to find a muſcle at the end of each track.

Theſe hollow ruts ſerve as a ſupport to the muſcles, to keep them up on the cutting part of their ſhell; and in digging the earth *this* way, and *that*, they catch probably ſome fry of fiſh, or other little food on which they live.

In conſequence of moving they might meet and engender together. I have never found any

any ſpawn in muſcles; but in the ſummer you may find a great deal of milk, and of ſlimy matter, in the ſame muſcle; this makes me conjecture that they may be both ſexes in one.

The large gland of the tufted muſcle is quite full of a very white milk in the month of September. I think it well worth obſerving with regard to this milk that it curdles as ſoon as it is thrown into the water. This coagulation makes me conjecture that muſcles do not throw their milk into the water, for it would become uſeleſs for generation; I ſhould rather think that a muſcle inſinuates its milk into another muſcle at the time of copulation: the ſame thing is probable with regard to other fiſh, and that they do not throw their milk into the water as is commonly believed.

Ariſtotle ſays that he had been told there is a large ſort of ſhell fiſh that leaps and vaults. I have before hinted that this philoſopher was not deceived, for I have ſeen by chance the large ſort of pond muſcle bound on the ſurface of the water; this leaping is effected in the following manner. Theſe large ſorts of muſcles have ſhells that are very light, extremely thin, and ſo broad that they can beat with them the ſurface of the water, as birds *do* the air with their wings. There is at the back of theſe ſhells, a large elaſtic ligament, in the manner of an hinge, and two thick

muſcular parts within that cloſe them: this is ſufficient for leaping, for all that is requiſite for that purpoſe is that theſe ſprings act ſuddenly one after another, and that the fiſh ſtrike the water with ſufficient force and quickneſs. What farther favours this motion is, that the articulation called ginglymus, which is in the ſhells of thoſe that do not leap, is not to be found in theſe; it would be embarraſſing.

Memoirs 1706, *pag.* 56.

Of the lavignon.

The ſhell fiſh to which the name of lavignon hath been given, on the coaſts of Poitou and Aunis, is undoubtedly a ſpecies of the chamæ, ſince it hath the character eſſential to that kind, which is being bivalvular, and always remaining a little open. They have likewiſe *this* in common with the ſpecies that Rondelet ſpeaks of, that their ſhell is thin and very brittle, inſomuch that you may eaſily break it between two fingers; and they live like the chamæ in the mud; but they differ at the ſame time from thoſe ſpecies, that Geſner ſays are called *flames* in French, and in Italian *peppered*, becauſe they produce on the tongue the ſame effect as pepper; whereas the taſte of the lavignon is very inſipid. Their ſhell is very ſmooth and white, particularly on the inſide; for oftentime the oldeſt part of the external ſurface of this ſhell, that is to ſay, the parts near its ſummit, have

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a blackiſh colour, which they have taken from the black mud in which the lavignons chiefly live; they keep themſelves buried in this mud ſometimes more than five or ſix inches deep. On whatever ſide you place the lavignon, provided you do not let it reſt directly on the ſummit of its ſhell, it will eaſily force its way under the mud: this it effects by putting forth a part which reſembles a leg; it hath a power of lengthening out this part, and making it pointed, in order to open its way the better through the mud. The manner it riſeth back out of the mud cannot be diſcerned, but it is probably effected by a contrary uſe of the ſame part; I mean, that it puts out from the edges of the ſhell the extremity of this part, bends it back and flattens it as much as it can, in order to ſweep away the mud that is above. What facilitates its motion both downwards and upwards is, that its ſhell is made ſomewhat like a wedge. The lavignon can glide likewiſe upon the mud, by puſhing out its leg againſt the mud, and forcing the ſhell forwards, as a man in a boat puſhes himſelf on with a pole. Mr. De Reaumur obſerves however, that it cannot ſink under the mud further than the length of the two horns or tubes, that it can put out of its ſhell, will permit. With theſe horns it takes in and throws back water, which muſt therefore always have a communication with the water that is above: it

Vid. plate 2d, fig. 1ſt, C C.

it is from thence that there are in the mud, which covers the lavignon, one or two little holes of the diameter of his horns, which ſerve to diſcover him.

The length of theſe horns, in other ſhell fiſh which have them, determines likewiſe the depth they ſink to in the mud.

Of the ſtar-fiſh. Vid. plate xi, fig. 2d.

The ſtar fiſh, although it hath 304 legs to each of the five *radii* that compoſe it, *which* have occaſioned the name of ſtar to be given it, gains no ſwiftneſs from them; its 1520 legs give it no advantage over the muſcle that hath but one. What an amazing variety in the works of nature! To ſpeak properly theſe legs are but a kind of horns, like the horns of our garden ſnails, which it lengthens and contracts at pleaſure. By extending a part only of *thoſe* of each radius, and faſtening them ſucceſſively on ſome ſolid body, they draw themſelves along. In order to convey an idea of the manner in which they extend their legs, it is neceſſary to lay open the internal parts of one of the radii. On cutting the hard ſkin of the upper ſurface, or the ſurface oppoſite to *that* where the legs are ſituated, the internal part of the ſtar-fiſh appears divided by a kind of cartilaginous body: this body ſeems compoſed of a great number of *vertebræ*, diſpoſed in ſuch manner that you find a groove in the middle, which they form by their aſſemblage: on each ſide of this groove you ſee two rows of elliptical

elliptical ſpheroids or oval bladders, extremely tranſparent, ſomewhat more than a line long, but leſs in bigneſs. They look like ſtrings of pearls. Theſe little bladders are formed of a thin membrane, but very ſtrong, and the inſide is full of a water. It is not difficult to diſcover that theſe bladders are ſubſervient to the extenſion of the legs; one begins to ſuſpect it as ſoon as one obſerves that the number of bladders is equal to *that* of the legs, and that each bladder correſponds to a leg: but the whole ingenious mechaniſm diſplays itſelf by preſſing with a finger ſome of theſe bladders; you then ſee them empty themſelves, and at the ſame time perceive the correſponding legs to ſwell. Laſtly, after having ceaſed to preſs them, you ſee them *fill again*, whilſt the legs *ſubſide* and *ſhorten*. It is evident that the ſtar-fiſh need only to preſs the bladders, in order to make the legs ſwell, in the ſame manner as they are preſſed by the finger; and it is eaſy to imagine a thouſand ways by which they may effect *this*. The bladders being preſſed diſcharge their water into the legs, which ſwell and extend themſelves immediately; but as ſoon as the ſtar-fiſh ceaſes to compreſs the bladders, the natural reſilition of the parts cauſes the legs to ſink, ſhortens them, and drives back the water into the bladders, from whence it was derived.

A viſcous matter ſerves to faſten the ſtar-fiſh when they have a mind to fix themſelves. This viſcous matter is conveyed to the extremities of thoſe numerous legs; and when a leg is glued againſt a ſtone, it is eaſier to break it than to detach it from thence.

Vid. plate 2d, fig. 3d and 4th.

M. De Reaumur hath obſerved a ſpecies of ſtar-fiſh which hath five radii like that we have been ſpeaking of, but which hath no legs to theſe radii, and which differs beſides from the other in *this*, that the radii have the ſhape of the tails of lizards. The five radii are *themſelves* the legs; the animal faſtens two of them on the place whither it would advance, in the form of *hooks*, and drags itſelf along on thoſe two, whilſt the radius, that is oppoſite to them, bends itſelf in a contrary direction, and, thruſting againſt the ſand, puſhes forward the body of the ſtar towards the ſame place. There are two others that continue unactive, but they would no longer be *ſo* if the animal wanted to turn to the right or left; and we ſee how by this means it can move on all ſides with equal eaſe, never employing more than three legs or radii at a time. Perhaps likewiſe nature hath given it five legs, becauſe, according to Mr. Reaumur's obſervation, they are eaſily broken, and it is proper the animal ſhould have a reſerve.

Mr. De Reaumur hath ſince *diſcovered that the ſtar-fiſh, like the polypus,*

Per

Per damna, per cædes, ab ipſo
Ducit opes animumq; ferro.

Vid. Mr. Reaumur's preface to his ſixth vol. of the hiſtory of inſects, pag. 61.

Of the ſea-urchins.

The ſea-urchin, or hedge-hog, takes its name from the thorns or prickles with which it is covered. There are ſeveral different ſpecies of this fiſh.

Naturaliſts have with reaſon believed that the ſea-urchins make uſe of their prickles as legs. I have ſeen them walk with theſe prickles in circumſtances where it was not poſſible for me to be miſtaken. Not only have I ſeen them move themſelves by their means, when I have put them in veſſels where ſea water covered them a little, and by conſequence where it was eaſy to obſerve them; but having put the ſame animals even upon my hand, I have ſeen them execute their progreſſive motion with their prickles alone. This fact is therefore certain, however contrary it may be to the obſervations of Mr. Gandolphe. Beſides theſe prickles, which are truly legs, they have likewiſe what reſembles the horns of ſnails; ſo that we ſhall give them the name of horns. Their uſe is far different from that which Mr. Gandolphe hath attributed to them; inſtead of ſerving for the motion of ſea-urchins, they ſerve to faſten them. The ſea-urchin employs them likewiſe, whilſt he is in motion, in

Vid. plate 2d, fig. 5.

in order to diſcover or feel the ground about him, as ſnails make uſe of theirs, or as a blind man feels with a ſtick the bodies that are in his way.

For this reaſon the ſea-urchin lengthens out, and ſhortens, alternately theſe horns during his march; but the number of them is much greater than Mr. Gandolphe imagined. The urchin hath them not only about the mouth, as Mr. Gandolphe obſerved, but amidſt all the prickles, particularly on the upper ſurface of his body.

The proviſion, with which ſo little an animal is furniſhed, is ſomething marvellous: It hath 1300 horns, which ſerve for keeping it at reſt; and this is done by applying their extremities to ſome body, and gluing them to it, as we mentioned of the ſtar-fiſh, ſo ſtrongly, that if you would employ a force ſufficient to unfaſten them, you would rarely effect it without breaking a part of thoſe that held the animal; and it hath more than 2100 prickles, which it may make uſe of for moving. Thoſe which it makes uſe of the moſt commonly are about its mouth; as they can incline equally on all ſides, it can likewiſe advance every way with equal eaſe. The prickles which are the neareſt, and thoſe which are the moſt remote from the place whither it is determined to move, are ſubſervient to it at the ſame time; it draws itſelf on with the firſt, and puſhes itſelf forwards

wards with the latter. How many muſcles are requiſite to put in motion, on all ſides and ſeparately, 2100 legs and 1300 horns!

All the *ſorts* of urticæ have been diſtributed into two kinds by Ariſtotle in his hiſtory of animals, lib. 5. chap. 16. of which one comprehends *thoſe* that remain their whole life fixed in the *ſame* place like plants; and the other, on the contrary, contains all the ſorts of urticæ that change their place, and love the ſhores and level places. Of the urticæ marinæ, or ſea nettles.

My own obſervations give me reaſon to doubt of the exactneſs of this diſtribution by Ariſtotle, ſince I have not been able to find any ſort of urticæ, even among thoſe that keep in the holes of ſtones, but what were capable of ſome progreſſive motion. Indeed the greateſt part of *thoſe* we find faſtened upon ſtones move themſelves ſo ſlowly, that, reſpecting *appearances*, there is great reaſon for thinking *them* unmoveable; and I ſhould have taken them undoubtedly as *ſuch*, if I had examined them only on the ſea-ſhore, their progreſſive motion being as ſlow as *that* of the hand of a clock, for they ſcarce move an inch or two in an hour.

I know not whether there is any better foundation for giving them the name of urticæ, or nettles, becauſe it is pretended that they cauſe, like that plant, a burning itching in the parts that have touched them; for all the ſorts of urticæ, which come upon the

the coaſts of Poictou and Aunis, produce not any ſuch effect.

Pliny, although he allows them the ſenſe of feeling *equidem & his inesſe ſenſum arbitror*, yet he cannot prevail with himſelf to rank them amongſt animals, but makes them, after Ariſtotle, of a middle nature between plants and animals, *quæ neque animalium, neque fruticum, ſed tertiam quamdam ex utroque naturam habent* ; he doth not however eſpouſe the reaſons aſſigned by Ariſtotle ; for one of the greateſt reſemblances, that Ariſtotle found between the urticæ marinæ and plants, was that the urticæ did not appear to him to have any paſſage for the diſcharge of excrements, whereas Pliny ſays that they diſcharge their excrement by a fine tube, *excrementa per ſumma tenui fiſtulâ reddi*. This tube may well be ſuppoſed to be one of the horns of the urtica ; but what theſe horns throw forth hath not at all the appearance of excrement, ſince it is a very clear water.

Be that as it will ; if we keep to common notions, we muſt conſider the urticæ marinæ as real animals ; for how can we refuſe the name of animals to bodies ſo well organiſed, that give not only marks of ſenſation when they are touched, but which catch fiſh, and particularly ſhell-fiſh, and eat them : laſtly, which have a progreſſive motion, as Ariſtole and Pliny have acknowledged with regard to ſeveral ſorts ?

The

The urticæ take ſucceſſively ſo many, and ſuch different figures, that it is ſcarce poſſible to deſcribe them under any determinate figure; it may be ſaid in general, however, that the external figure of the body of the urtica approaches pretty near to *that* of a truncated cone, the baſis of which is applied to ſtones, to which we find it always adherent; but the baſis of this cone, which appears often circular, is ſometimes elliptical, ſometimes of an irregular figure; ſometimes the cone is perpendicular to its baſis, ſometimes oblique; its height varies in proportion as the baſis is enlarged or diminiſhed; I mean, that when the baſis becomes greater, the height becomes leſs, and that it is more lofty as the baſis is more confined.

The upper ſurface of the urtica, or that which is oppoſite to the baſis, is not ſo flat as ſhould be in a truncated cone, it is commonly convex. In the middle of this ſurface is an opening ſometimes bigger and ſometimes ſmaller, according as it pleaſes the urtica to increaſe or diminiſh it.

In order to form in the imagination a pretty exact idea of the urtica, you may conſider it under the ſhape of one of thoſe purſes wherein counters for cards are kept, with this difference however, that its opening, which reſembles that of the purſe, cloſes itſelf without the reſt of the outſide covering of the urtica being puckered from top to

bottom, as thoſe purſes are to which we have compared it.

When the urtica enlarges greatly this opening, almoſt all its horns appear; they are in figure like the horns of ſnails, but their function reſembles more perhaps *thoſe* we have mentioned of certain ſhell-fiſh, ſince it often happens that the urtica throws out very fine ſpouts of water at their extremities, when you touch it.

If the urtica, not content with enlarging greatly its opening, turns back likewiſe the circumference of this purſe, in the manner one turns back a ſtocking, ſo as to expoſe externally a part of its internal ſurface, you *then* ſee all its horns diſplayed; which makes a very ſingular appearance, and doth not ill repreſent a flower in bloſſom.

The variety in the colour of urticæ of different ſpecies, or of the ſame ſpecies, equals almoſt the variety of the figures, that the urtica aſſumes ſucceſſively; ſome are greeniſh, others whitiſh, others of a roſe colour, and ſome others of different ſorts of brown. In ſome urticæ theſe colours appear throughout the whole ſurface, in others they are intermixed with ſtreaks, or ſpots; ſometimes theſe ſpots are diſtributed regularly, ſometimes irregularly, but always in a very agreeable manner.

Vid. plate 3d, fig. 1ſt. Some urticæ have a fleſh harder than *that* of others; but the moſt conſiderable difference

rence is that the external ſurface of the fleſh in *ſome* is ſhagreened; it is ſcarce neceſſary to mention that the external fleſh is not covered by a ſhell, or by any ſubſtance like it.

The purſe is the cover or caſe, in which all the parts of the urtica are contained; but in ſuch manner that they never fill intirely the caſe, unleſs the urtica hath cloſed its opening. All this purſe, that contains the urtica, is a part truly muſcular, conſiſting of ſtraight and circular muſcles, to which I ſhall give the name of tubes; becauſe you often find them filled with a watery liquor, that runs out upon piercing a tube. Indeed theſe tubes are not viſible, but when they are diſtended by water; and it depends on the urtica, to make which it will of theſe tubes perceivable, by ſwelling the one or the other throughout their whole extent, or in a part only, as itſelf pleaſes: their whole progreſſive motion conſiſts in general in *this*, that all the muſcles both the circular and the ſtraight, that are of that ſide to which the animal would move, ſwell, and extend themſelves, and by conſequence occupy a little part of ſome new place, whilſt the muſcles of the oppoſite ſide continue flaccid, and are drawn on by that part which advances; this motion however is as ſlow, and as little perceivable as the hand of a clock.

It is by means of the ſwelling, and ſubſiding of theſe muſcles, both ſtraight and cir-

cular, that the urticæ change their external figure in ſo many ways.

I have ſeen *ſome* urticæ make uſe of *their horns* for moving themſelves; theſe urticæ were of *thoſe* ſorts that live in the holes of ſtones; but when they trailed themſelves by means of their horns, their poſition was inverted; that is to ſay, their baſis was uppermoſt, and their horns downwards. Theſe ſorts of urticæ have their horns extremely gluiſh, and even rough to the touch, ſo that they can eaſily draw themſelves on by their means.

It is very ſurpriſing that an animal ſo ſoft in its texture as this is, that hath no foot, or any thing equivalent to it, can devour animals ſo well defended by their ſhells, as muſcles and other bivalvular ſhell-fiſh are. It is certain however, that the urticæ feed on the fleſh of theſe animals; but it is not eaſy to diſcover by what artifice they draw them out from their ſhells; all that can be diſcerned is, that they introduce thoſe ſhell-fiſh quite intire through their mouth, or rather opening.

After having thus introduced the ſhell-fiſh intire into their body through this opening, they contract it in ſuch manner that there is no external appearance of ſo large a body being contained within their *own*: it is *then* that they ſuck thoſe ſhell-fiſh at their eaſe; but the manner of their ſucking, as it

is

is tranſacted internally, cannot be diſcovered; after having ſucked out the fiſh, they diſcharge the empty ſhells through the ſame opening as they had introduced them.

For the expulſion of the ſhells, the urtica not only enlarges greatly the opening, but turns back the edges of it, as one turns back a ſtocking. The ſame turning of the inſide outwards, both of the purſe, or external covering, and of the mouth of the animal, ſerves likewiſe for the delivery of their young, for the urticæ are viviparous and bring forth ſometimes a dozen at a birth, but always one after another, although the opening they make is wide enough for letting paſs ſeveral at a time.

But the moſt remarkable thing of all in the urticæ is, what Mr. De Reaumur hath *ſince* mentioned in his hiſtory of inſects, that ſeveral of theſe conical animals having been divided in two by a ſection along the axis, the two halfs that were ſeparated became by degrees complete cones, and each formed a perfect urtica. Vid. preface to the ſixth volume of the hiſtory of inſects, pag. 62.

There is another ſort of *urtica marina*, or ſea nettle, that faſtens itſelf to nothing, and from thence is called the *wandering* urtica; it hath a vaſt variety of names on the different coaſts of the kingdom; I ſhould be inclined to call it the *ſea gelly*, a name that characteriſes very properly the ſubſtance of which it is

compoſed; for it diſſolves away in the hand. It could not be ranked in the number of animals, but that one obſerves in it a motion of ſyſtole and diaſtole, the only ſign of life which it gives.

Of the lepas or limpet.

We have ſeveral times mentioned that the ſhell-fiſh faſten themſelves to ſtones, and other bodies, by means of a glue. If immediately after you have detached a lepas or limpet, you apply a finger on its baſis, or on the part of the ſtone which it touched; when you would draw away your finger you find it held by a glue that was imperceptible to your ſight.

Now it is to be remarked that if the water hath ever ſo little wetted the ſtone, or the baſis of the animal, the glue then will have no hold on the finger that touches it: likewiſe when in taking off the lepas you have made a conſiderable wound at its baſis, the glue is *then* no longer ſenſible to the touch; the wound lets out the water which hinders its effect.

From hence I think we may conjecture the method that nature hath taught this ſhell-fiſh, in order to break the bonds which are often neceſſary for its defence againſt the agitation of the waves, but which would cauſe it to periſh if they withheld it at the time it ought to go and ſeek its nouriſhment.

To conceive the manner by which it faſtens and unfaſtens itſelf, you muſt conſider

the baſis of the animal as full of an infinite number of little grains like ſhagreen, a part of theſe grains are little cells filled with water; of this there can be no doubt, ſince they let the water run out as ſoon as they are opened by a wound at the baſis, how ſlight ſoever the wound may be. Another part of theſe grains contains the glue we are ſpeaking of, or if you will there may be ſome other veſſels that convey the glue throughout the whole baſis.

If the animal wants to faſten itſelf, it ſqueezes out the glue from the veſſels that contained it, and preſſes its baſis thus moiſtened againſt ſome ſtone that the ſea hath left bare during the ebb. If it would quit the ſame ſtone, it need only to preſs thoſe cells that contain the water; the water runs out, dilutes the glue, and the animal is at liberty to go and ſeek its food.

Moreover the animal hath not the liberty of attaching itſelf ſo often as it might be willing; it hath not a ſufficient ſtock of glue for that purpoſe.

Having detached two or three times ſucceſſively in a ſmall compaſs of time ſeveral lepades, they could no longer faſten, or faſtened themſelves very weakly, their ſource being exhauſted; they wanted time to repair the waſte that had been made.

Borelli hath placed the lepas amongſt thoſe fiſh that continue their whole life fixed to

the ſame ſpot; but Ariſtotle hath taken care to remark that it doth detach itſelf from the ſtones in order to ſeek its food. I have never ſeen it on the ſea ſhore have any other motion than that of lifting up its ſhell, a line, or a line and half from the ſtone, to which its baſis is applied, and making it fall back again with great quickneſs as ſoon as it was touched.

But thoſe which I have kept alive at home have ſhewn me that they have a progreſſive motion, and the manner in which they execute it; it is by means of a large fleſhy part, that is in the center of the ſhell, and makes the baſis of the animal; its ſubſtance is much more ſolid than that of the other parts, and its ſize is equal to *that* of all the other parts taken together. And it is a remark I have made on all the ſhell-fiſh I have hitherto ſeen, that the part, which they employ for their progreſſive motions, hath almoſt as much fleſh *alone* as all the reſt of the body of the animal.

The lepas makes uſe of this part to move as our land ſnails employ a kind of foot for the ſame uſe; and indeed their ſlowneſs of motion is pretty much alike.

Hiſtory and Memoirs 1710, 1711, 1712.

Of the razor, cutler or ſheath-fiſh.

It is certain that there is no animal which would more excite our admiration than the ſheath-fiſh, if we could ſee all that Pliny re-

lates of them. He mentions that they are not only luminous in ſome certain circumſtances, as divers rotten fiſh and other ſort of fleſh are in the dark; but that the more freſh they are, the more light they diffuſe; that they are full of a water whoſe nature it is to be luminous; it ſhines in the mouth of thoſe who eat them; if a drop of it falls upon the ground, upon the cloaths, or upon the hands, thoſe drops appear with all the ſplendor of light; in a word the nature of this liquor is the ſame as that of luminous bodies. Vid. Pliny, lib. ix. cap. 61. In vain did I ſeek, ſays Mr. De Reaumur, for this property in the ſheath-fiſh, and was inclined to think it a mere fable of Pliny's; but I have ſince found that I was only deceived by Rondelet, Aldrovande, Geſner, Jonſton; in a word, by all the modern naturaliſts who have without heſitation taken the fiſh mentioned by Pliny, under the names ſolen, aulos, donax, onix, dactylus, and moſt commonly dactylus, for what is called *coutelier* on the coaſt of Poitou, and *couteau* on the other coaſts of the kingdom. It is to the dactylus that Pliny attributes the property of ſhining.

I have lately diſcovered that we have another ſhell fiſh, which produces all the phenomena that Pliny hath related of the dactylus. By its name likewiſe it reſembles more the dactylus of Pliny than the coutelier or ſheath fiſh. It is called *dail* on the coaſt of Poitou.

Not

Not that I think the modern naturaliſts have been deceived in giving the name of coutelier or ſheath-fiſh to the dactylus of Pliny; for the ſheath-fiſh reſembles more the dactylus of Pliny in its ſhell than the dail. Perhaps Pliny conſidered the dail as a ſpecies of the ſame *genus* as the ſheath-fiſh; and not having ſeen the fact himſelf, but taken it on report, hath attributed to *one* ſpecies what is peculiar to *another*.

Surpriſing luſtre of dails or dottle-fiſh.

However that be, for there is a real difficulty in the caſe, yet it is certain the dails are luminous to the degree, and in all the circumſtances, which we have juſt mentioned from that author.

It is ſcarce neceſſary to take notice, that it is not the ſhell which is luminous, but the animal, that it covers. It is more luminous in proportion as it is freſher, and but newly taken from the ſea. In glow-worms it is but a part of the body which ſhines, whereas the dails ſhine throughout the *whole*. I have taken them entirely out of their ſhells, and carried them into a dark room; their whole ſurface appeared luminous, there was not ſo much as a dark ſpot, not a point that did not ſhine with a peculiar ſplendor. It is not to the external ſkins alone that this property is attached, it is common to all their fleſh, to all that compoſes their body. If you tear them, cut them, the ſurfaces which are formed by thoſe diviſions are luminous, as the

the others were; in a word, their whole ſubſtance is luminous in the ſame manner as are the fragments of a coal that is thoroughly lighted, or as the urinary phoſphorus is in every part. Our dails are true natural phoſphori, which like the artificial phoſphorus make all the bodies againſt which they are rubbed become flaming; the fingers can ſcarce touch them without being luminous; and, as Pliny ſays, they will ſhine in the mouth of thoſe who eat them, and make the tongue, the teeth, and all parts of the mouth to which they have been applied, become luminous. This ſhell-fiſh newly caught hath, like oyſters and muſcles, a great deal of water; if you handle it a little, drops fall from it, and thoſe drops themſelves are luminous, as Pliny exactly relates.

The light that theſe fiſh give to bodies, againſt which they have been rubbed, is not of long duration; it ceaſes as ſoon as what they have left on thoſe bodies is become dry. When I have neglected to waſh my fingers immediately, I have ſeen the luminous quality which they had acquired grow weaker by degrees, and at length entirely diſappear. But when I wetted my fingers afterwards in order to waſh them, I perceived them almoſt as luminous as they had been before. This gave me an inclination to try if one might not make of this fiſh a durable phoſphorus, a phoſphorus that one might

might preſerve as long as one would. I cauſed therefore ſome to be dried, which in drying have, as I expected, loſt their property of ſhining. At the end of four or five days, when the fleſh has been well dried, I have moiſtened them either with common water, or with water in which ſea ſalt has been diſſolved. Then they began afreſh to ſhine, as I had expected; but that ſplendor being much fainter than the firſt, I concluded that theſe fiſh would not become again a very ſplendid phoſphorus. I have endeavoured to preſerve them by other ways, which have not ſucceeded better. I have put one of theſe fiſh in brandy, it loſt almoſt immediately its whole property of ſhining.

It was towards the end of autumn that I made theſe experiments; then and at any time when the weather is not too hot, you may keep theſe animals *ſhining* for ſeveral days; but in proportion as they grow ſtale, they become leſs ſhining; and when corrupted to a certain degree they are no longer *ſo* at all. Perhaps likewiſe ſome of theſe ſhell-fiſh that are extremely corrupted may hinder thoſe that are quite freſh from ſhining; an experiment gave me reaſon to think ſo. I ordered the fiſhermen to get ſome dails whilſt I was preſent, which, on examining them in the dark, gave no luſtre. It is to be obſerved that theſe fiſh live in the midſt of a ſoft ſtone, which ſurrounds them on all

all ſides; that they are *there* in a kind of priſon, from whence they never come out their whole life long; in order to get them you break the ſtone. Now amongſt thoſe dails, of which I was ſpeaking, and that *freſh* gave no luſtre, they had put ſome which had died in their holes, and were become exceſſively ſtinking. Perhaps the impreſſion that *theſe* made on the others extinguiſhed, if I may be allowed the expreſſion, their whole light. I could not aſcertain the fact, becauſe I could get no more of the fiſh at that time. Perhaps likewiſe there are ſome ſeaſons when theſe animals will appear more luminous than at others. The fermentation that there is in animal machines is not always the ſame, and one particular ſort of fermentation may give to ſome kinds of fleſh the diſpoſition neceſſary to become luminous. The ſeaſon when the animals *couple* is a time when there is a particular ſort of fermentation. It is probable that the light, which glow-worms diffuſe, owes a part of its vivacity to this fermentation.

Other inſects likewiſe ſhine at particular times. I have met with millepedes that were very lively and of a common ſort, which gliſtened at leaſt as much as glow-worms; and I have often met with other millepedes, which have appeared to me of the ſame ſpecies, that were by no means luminous.

There

There may therefore be ſeaſons when our dails would not ſhine, but I am not ſure there are ſuch ſeaſons; and although I have found ſome that were not ſhining, though freſh, yet the exceſſively corrupted dails, with which they were mixed, might have contributed to this phenomenon, might have made *them* loſe immediately the property of diffuſing light, in like manner as I mentioned before that brandy occaſioned *one* to loſe it.

The dail was the only ſhell-fiſh on the coaſt of Poitou in which I found the property of ſhining. Before I conclude this article, I ſhall juſt mention that the dails are of the genus named *pholas* by the ancients; we have two ſpecies of them very common on the coaſts of Poitou and Aunis. Their figure is pretty much like a truncated cone.

There is not probably in nature a progreſſive motion more ſlow than that of the dail; immured as he is within his hole, he advances only by approaching towards the centre of the earth; the progreſs of this motion is proportioned to that of the growth of the animal; as he increaſes in extent, he ſcoops deeper his hole, and by that means deſcends lower. He is commonly found at a depth double at leaſt to the length of his ſhell. The part he makes uſe of for ſcooping this hole, is a fleſhy part in ſhape of a lozenge, ſituated near the inferior edge of the ſhell. Although it is of a ſoft ſubſtance, there is no wonder

wonder that it ſhould be able to pierce an hole deep enough in an hard body, as it employs on it a great deal of time. I have ſeen theſe dails employ this part for the uſe that I attribute to it, after having drawn them out of their holes, and placed them on a clay as ſoft as mud; they ſcooped themſelves an hole, and in a few hours made it as deep as *that* on which they are labouring for ſeveral years; indeed they found *here* much leſs reſiſtance, and the need they had of concealing themſelves made them probably accelerate their work.

The young dails are found in clay, and the old ones in ſtone; from the ſhape of the holes correſponding to the figure of the ſhell, much narrower at the top than at the inferior extremity, it is certain that the old ones are in the ſame holes as when they were young; for ſhould it be ſuppoſed that they quitted their firſt holes, and had an artifice of enlarging them at the top when they had a mind to quit them, it would be ſufficient, in order to ſhew the falſhood of ſuch a ſuppoſition, to take notice that all the empty holes which are found are conical, like thoſe that are inhabited; whereas if the dails had quitted them the empty holes would be cylindrical.

The conſequence to be drawn from the preceding facts is extremely clear, that the ſtone hath been formed ſince the dails penetrated.

trated. Indeed there is no room to doubt but the ſea water is proper for petrifying; pieces of wood, that one frequently meets with upon our coaſt more than half petrified, are an inconteſtable proof of it. It is highly probable that the dails live a long time; for the change of clay into ſtone, which is effected during the life of a dail, can proceed but ſlowly and by imperceptible degrees.

The dail hath likewiſe two tubes which it puts forth at the entrance of the hole. The uſe of them is the ſame as that of the tubes of the lavignon and other ſhell fiſh; they employ them alternately in ſucking in and rejecting water. When you touch their hole, they draw them back quick into their ſhell, and, ſquirting out the water they contained, make ſeveral little ſpouts.

Memoirs 1712, *pag.* 119 to 133; *Memoirs* 1723, *pag.* 200.

Remark on the glow-worm.

Having mentioned glow-worms in the preceding article in ſpeaking of the luſtre of the dail, I muſt obſerve that it is ſeldom but in the warm ſeaſons that *they* ſhine in this country, and that thoſe who do ſhine are all females. It is well known that they are inſects without wings; but thoſe, who have read the authors that treat of inſects, know likewiſe that the male of this inſect hath wings; the figure of the male is well repreſented

ſented in Mouſet's theatre of inſects: he flies by night, and the female glow-worm throws out a light, like Hero for Leander, to direct him which way to ſteer his courſe.

I knew not the male of the glow-worms but by books, it had never yet happened to me to find any; when a female glow-worm luckily gave occaſion ſome years ago to my diſcovering one. I was holding in the night-time a glow-worm in my hand, and obſerving the vivacity of its light, when another inſect came and placed itſelf on my hand; it conſorted immediately with the glow-worm, and continued a good while in copulation. Since *that* it hath happened to me ſeveral times to take other male glow-worms by holding females in my hand. Moreover there are ſeaſons when the female glow-worms do not ſhine ſcarce at all, and perhaps thoſe ſeaſons are when they have no amorous diſpoſition.

Memoirs 1723, *pag.* 203.

Of the razor, cutler, or ſheath-fiſh.

We have been diverted from the conſideration of the razor or cutler-fiſh, and ſhall now return to obſerve that this animal which inhabits a cylindrical ſhell, reſembling a round ſheath of a knife, keeps itſelf always perpendicularly ſunk in the ſand, but in ſuch manner that its head is always uppermoſt: its head is diſtinguiſhable, not by its figure, but by two tubes, which receive and reject

water neceſſary for its reſpiration. The lower part of the ſheath-fiſh is that which ſerves for its progreſſive or perpendicular motion; this motion is confined to a foot and half, or two feet of vertical height, and is effected by means of a kind of leg that it emits from its ſhell. Having a power of varying the ſhape of the extremity of this leg, ſo as to make it ſomewhat *pointed*, in order to penetrate through the ſand, or to *ſwell* it into the figure of a bowl, in order to increaſe the ſurface, and conſequently the reſiſtance from the ſand, it can ſink down or raiſe itſelf up, to ſuch an height, however, that the inferior part of the ſhell is always under ſand.

It is eaſy to make the ſheath-fiſh perform theſe two motions; when the tide being out hath left bare the hole where he lodges, you need only throw into it a little ſalt, and the ſheath-fiſh immediately riſes half out; it is eaſy then to take him; but if you would ſee him ſink back into his hole, you need but touch him; after *that* if you throw in ever ſo much ſalt he riſes up no more, but is ſenſible of the ſnare that is laid for him.

Mr. De Reaumur thinks that it is through an averſion to the ſalt thrown in, and in order to ſhake it off and rid himſelf from it, that he riſes out of his hole; for if you put ſalt upon thoſe tubes or horns with which he reſpires water, little cylinders placed end-

ways on each other, of which thoſe tubes are compoſed, ſeparate at the *places* of their joints, *which* have been touched by the ſalt, and fall off, or need only be touched very gently to make them fall; it is plain, therefore, that ſalt deſtroys an organ that is abſolutely neceſſary to the animal. Strange that he ſhould live only in ſalt water, and yet that ſalt ſhould be ſo contrary to him!

Hiſtory 1712, *pag.* 13, *Memoirs pag.* 119.

Of the pinna marina.

This ſhell-fiſh, which is a kind of great muſcle, conſiſts of two large ſhells, rounded at the top, and very pointed at the bottom, very uneven without, and very ſmooth, and of a brown colour within, inclining towards the point to the colour of mother of pearl: there are of different ſizes from one foot to two and half in length, and have in their wideſt part about one third of their length; their ſhells are ſo thin that they are tranſparent. What is the moſt remarkable in them is a kind of tuft about 6 inches long; this tuft is ſituated towards the point of that ſide which is oppoſite to the hinge; it is compoſed of ſeveral filaments of a very fine and brown ſilk. Theſe filaments by the microſcope appear hollow, if burnt they give an urinous ſmell like ſilk. The ancients have named this tuft of threads byſſus, whether on account of its reſemblance to the byſſus, from whence they ſpun their precious ſtuffs, or

Plate 3d. fig. 2d.

whether it was itſelf the byſſus of which they made thoſe ſtuffs; for the moſt ſkilful critics have not well cleared up what was meant by the byſſus of the ancients; they have only diſtinguiſhed two ſorts of it, the one of Greece, which was to be found only in the province of Elis, and the other of Judea, which was the moſt beautiful. The ſcripture informs us that the latter ſerved for the ornaments of the prieſts, and likewiſe that the rich man in the goſpel was cloathed with it; but as under the name of byſſus the ancients confounded cottons, wads, in a word, every thing that was ſpun, and was more precious than wool; it is not eaſy to ſay what their byſſus was, and whether it was not entirely taken from the ſhell-fiſh we are ſpeaking of. This is certain that Ariſtotle names the ſilk of theſe ſhell-fiſh byſſus, that it can be ſpun, and that there can be no doubt therefore of its having been employed in the dreſs of great perſons in thoſe ages when ſilk was but little known, and very rarely ſeen. In reality this byſſus, although groſsly ſpun, appears much more beautiful than wool, and comes pretty near to ſilk; there are made of it even at preſent ſtockings, and other manufactures, which would be more valued if ſilk was leſs common. In order to ſpin this ſort of byſſus, they leave it for ſome days in a cellar, to moiſten and ſoften it; next they comb it to get out the filth that there may be in it; afterwards

terwards they ſpin it in the ſame manner as ſilk.

The fiſh that afford the byſſus, make uſe of it to faſten their ſhells to neighbouring bodies; for as they are placed upright on the point of their ſhells, they have need of theſe threads which they extend round about them, like the ropes of a maſt, to ſupport themſelves in that ſituation.

It is probable, ſays Mr. Geoffroy jun. that the pinna-marina forms theſe ſorts of threads, by the ſame mechaniſm as Mr. De Reaumur hath diſcovered in the ſea muſcles; but thoſe of the pinna are more beautiful, more ſilky, and, as Rondelet ſays, are as different from the threads of muſcles as ſilk is from hards of hemp, as may be ſeen by comparing them together.

Mr. De Reaumur hath ſince examined the ſtructure of the pinna-marina, and found the mechaniſm to be the ſame as in the muſcle: the only difference is, that as the pinnæ muſt rope threads much finer and longer than muſcles, their wire-drawing part is likewiſe much longer and more delicate.

Memoirs 1712, *pag.* 207, *Memoirs* 1717, *pag.* 183.

Of the purple of the ancients.

Pliny, *lib.* ix. *cap*, 36, ranks all the ſpecies of ſhell-fiſh, which give the purple dye under two kinds; the firſt comprehends the ſmall ſpecies of *buccinum*, a name which the

ancients gave to thoſe ſorts of fiſh, whoſe figure of ſhell bore any reſemblance to *that* of an hunting horn; and the ſecond comprehends thoſe ſhell-fiſh that bear the name of *purple*, as well as the tincture they afford.

Columna thinks, and hath probable reaſons to ſupport his opinion, that it is likewiſe this laſt kind which was called murex; that theſe different names have been given to this ſhell-fiſh, conſidered in different reſpects: the name *murex* excites the idea of chanelled points with which their ſhells are rough, as the name of *purple* recalls the idea of the colour derived from them.

Our coaſts upon the ocean do not afford any of the laſt kind of ſhell-fiſh; but one meets with very commonly a little ſpecies of buccinum, which furniſhes a purple dye. I have not obſerved on our coaſt that ſpecies of buccinum mentioned in the philoſophical tranſactions, Lowthorp's abridgement, vol. 2d, pag. 823. And I have but ſeldom found that which Columna hath got engraved in his treatiſe on the purple, as the true buccinum of the ancients; but I have not ſeen in it any of that liquor which gives the purple, as I have in the other buccinum: perhaps the difference of ſeas, or the difference of ſeaſons, in which I made my obſervations, are the occaſion of it.

The largeſt of the ſpecies of buccinum, common on our coaſts, is between 12 and

13

13 lines long, and between 7 and 8 in diameter, in the place where they are the biggeſt. Their ſize agrees very well with Pliny's account of the buccinum, which he calls *minor concha*; he deſcribes them more particularly ſtill, when he adds that they are ſnipped at the edge of their mouth, *rotunditate oris in margine inciſa*; ours are ſo likewiſe. There are of different colours, ſome white, others brown, others have ſtreaks of a ſand colour along the ſpirals of the ſhell, upon brown or white grounds; the external ſurface of theſe ſhells is commonly chamfered, but in two different manners; the chamferings of ſome are formed by kind of wreaths running the length of the ſpirals; and others have likewiſe other chamferings that run acroſs the firſt, and conſequently croſs the ſpirals of the ſhell. Plate 3d, fig. 3d.

Their progreſſive motion is performed in the ſame manner as *that* of ſnails, by means of a large muſcular part, to which we may give the name of foot or *paſtern* in ſnails; all the other ſorts of *ſpiral* ſhell-fiſh have a part very much reſembling *this*, and deſtined to the ſame actions; this part is never ſeen but when they would move themſelves, at other times it is intirely drawn back into their ſhells; it ſerves even to ſhut them up *there*, by means of a little lid or cover that is faſtened at its end: this little cover is given to all theſe ſorts of ſhell-fiſh, in order that they Vid. plate 3d, fig. 4th.

may be closed on all sides, as well as the *bivalvular* shell-fish; it is composed of an hard substance, although less hard than the shell. One may easily apprehend how these animals stop up with this cover, as with a sort of gate, the mouth of their shell; for it must be observed that this cover is attached to the superior surface of the end of their pastern, that is to say, to that part of the pastern, which being extended is nearest to the summit of the shell. Now it is easy to conceive that when these shell-fish have drawn back their foot or pastern into the shell, by bending it in such manner that the inferior part, or that which was applied to the ground, is brought back towards their head; it is easy to conceive, I say, that this cover will *then* stop up the mouth of the shell, since the surface of the pastern to which it is fastened will by that means be the nearest to the mouth; and all that is requisite for the purpose is, that the shape of the cover should be the same as *that* of the mouth of the shell.

Vid. fig. 4th, C.

Upon breaking the shell at some distance from its mouth, or head of the buccinum, and taking out the broken pieces, you discover a little vein, to use the expression of the ancients, or to speak more properly, a little reservoir, full of a liquor proper for giving the purple dye: the colour of the liquor contained in this little reservoir makes

it eaſily diſtinguiſhable, it is very different from that of the fleſh of the animal. Ariſtotle and Pliny mention that it is white, and indeed it is of a colour inclining to white, or a yellowiſh white: I ſhall excite a diſagreeable idea in mentioning the pus of ulcers, but at the ſame time a very proper one to convey an exact image of the colour of this liquor. The little reſervoir in which it is contained is not of equal bigneſs in all; it is commonly, however, about a line broad, and two or three lines long: you will eaſily conceive its poſition if you conſider the buccinum as a land ſnail, indeed it is a kind of ſea ſnail, and conſider the ſnail as ſtripped of a part of its ſhell, ſo as to leave bare its collar, or that maſs of fleſh which ſurrounds its neck; for it is upon this collar that the little reſervoir we are ſpeaking of is placed; its origin is ſome lines diſtant from the edge of this collar, and on its moſt elevated part, that is to ſay on that part which is uppermoſt, when the mouth of the ſhell is downwards. This reſervoir runs in a direction conformable to the body of the animal, that is to ſay, it goes from the head towards the tail, not in a ſtraight line, but winding the ſpiral of the ſhell.

It was this little reſervoir that the ancients were obliged to take out of the buccinum, in order to have the liquor it contains: they muſt have cut it out ſeparately from each fiſh,

fiſh, which muſt have been a tedious work if you conſider the quantity that is to be collected from it; for there is not ſo much as a good drop contained in each reſervoir. No wonder that the fine purple was at ſo high a price amongſt them. Ariſtotle and Pliny mention indeed that theſe little reſervoirs were not taken away *ſeparately* from the *ſmalleſt* ſhell-fiſh of this ſpecies; that *they* were only pounded in mortars, which was a means of diſpatching a great deal of work in a little time; and Vitruvius ſeems to give *this* as the general preparation, Architecture lib. 7, cap. 13.

It is, however, difficult to conceive how they could have a fine purple colour by this means; the excrements of the animal muſt have conſiderably altered the purple colour, when they were heated together, after being mixed in water; for the excrementitious matter is of a greeniſh brown, a colour which it communicated probably to the water, and muſt have changed very much the purple colour, becauſe the quantity of this matter is incomparably greater than that of the liquor.

I am the more convinced of *this*, as I have obſerved, that the more you take of the fleſh of the animal, in taking away its liquor, the leſs beautiful will the colour be.

The trouble, however, of getting out the little reſervoir of liquor from each buccinum, was not all that was requiſite: they threw

next

next all the little reſervoirs into a large quantity of water, which they kept for ten days over a moderate fire: that they kept it ſo long a time over the fire was not becauſe it was neceſſary in order to give the purple colour to the liquor, it would take it much ſooner, as I have been well aſſured by a great number of experiments; but it was neceſſary in order to clear it of the fleſh, and of the little veſſel itſelf that contained the liquor, which being diſſolved in warm water roſe in a ſcum to the ſurface, and were ſkimmed off.

The cauldron they made uſe of was of tin; we make uſe of the like cauldrons at preſent for ſcarlet dying: copper cauldrons would give a colour that would alter *that* which you deſign.

The ancients diſſolved a good deal of ſea ſalt in the water, with which they mixed the liquor of the buccinum, or of the purples. I do not believe they did it becauſe they ſuppoſed that the ſea ſalt would render the colour more beautiful; but perhaps they employed it only in order to keep the fleſh in the cauldron from growing putrid during the long time it was to continue there; for by growing putrid it would have ſpoilt the purple colour, as I have found by experience. I have made likewiſe ſeveral experiments, by which I am aſſured that ſalt doth not make the purple colour more beautiful.

In

In the *Journal des ſçavans of* 1686, they have deſcribed the ſingular changes of colours that happen to the liquor of the buccinum; if inſtead of taking out the veſſel which contains it, as the ancients practiſed, you only open it, and by ſcraping it get out the liquor, the linnen or other ſtuffs, whether of ſilk or wool, that ſhall have imbibed the liquor, will ſhew at firſt only a yellowiſh colour like to what *pus* would give; but the ſame linnen expoſed to a moderate heat of the ſun, ſuch as in a ſummer morning, takes in a few hours very different colours. The yellow begins at firſt to appear a little more greeniſh, it becomes a citron colour; to this citron colour ſucceeds a more lively green; this green changes into a deep green, that terminates in a violet colour; after which you ſee at laſt a very fine purple.

Theſe changes are made ſo much the quicker as the heat of the ſun is greater; you have ſcarce the time to perceive them *diſtinctly*, when the linnen is expoſed to the rays of the ſun at noon in ſummer.

Not only the heat of the ſun, but likewiſe that of fire produces the ſame effects: yet it is a fact worthy of remark, that the ſame degrees of heat from the fire and the ſun are not equally powerful in producing the colours; the heat of the fire muſt be much greater than that of the ſun to produce the ſame change of colour in the liquor,

liquor, as I have been convinced by experiments.

The air alone without ſunſhine, or the heat of fire, will produce the colours, but more ſlowly; if the liquor is thick, ſuch as it is when taken from its reſervoir, you muſt expoſe it to an high wind, and then it takes in a few hours the ſame colours ſucceſſively as it would in a moderate ſunſhine.

It may appear ſurpriſing that Ariſtotle and Pliny, who mention ſo often the tincture of purple, and the ſhell-fiſh that afford it, have not ſaid a word of thoſe changes of colours ſo worthy of remark, through which the liquor paſſes before it arrives at purple. It cannot ſurely be thought that they have neglected to tell us ſo ſingular a fact, becauſe it was too well known in their time; I am ſatisfied that ſuch a reaſon would not have induced them to paſs it over in ſilence: it is much more probable, and I think it the true ſolution of the difficulty, that they did not know it, becauſe they had not much examined theſe ſhell-fiſh *themſelves*, and have only given us on this ſubject as on many others the accounts that had been communicated to them. Thoſe which they had on this article muſt have been given them by workmen employed in the purple dying, or by perſons that had ſeen them work, and who could ſay nothing of a change that did not happen in the ordinary preparation of purple;

purple; for it muſt be obſerved that the liquor paſſes all of a ſudden to a red, when it is diluted in a great deal of water; and, as we mentioned before, their method was to mix it in cauldrons with a great quantity of water.

A new purple diſcovered.

Whilſt I was conſidering, ſays Mr. De Reaumur, the ſhell-fiſh I have been mentioning, I chanced to find on the ſea ſhore a new tincture of purple, which I was not in queſt of. Chance hath almoſt always a ſhare in our diſcoveries, and all that attention can do is to puſh *luck* to the improvement of natural knowledge, as at play to the improvement of one's fortune. I obſerved that the buccina (for I would preſerve to them their Latin name) were commonly collected together round certain ſtones, or under arches of ſand, which the ſea had made hollow by waſhing away the ſand underneath. I remarked, I ſay, that the buccina were aſſembled ſometimes in ſuch great quantities in theſe places, that you might gather them up in handfuls *there*, whereas they lay widely diſperſed every where elſe. I obſerved at the ſame time that theſe ſtones or arches of ſand were covered with certain grains, whoſe figure ſomewhat reſembled an oval. The length of theſe grains was ſomewhat more than *three* lines, and their thickneſs ſomewhat more than *one*; they appeared to me to contain a whitiſh liquor, inclining to a yellow.

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This reſemblance in colour to the liquor of the buccinum, and the manner in which the buccina were always aſſembled round theſe little grains, gave me a notion that there might be drawn from them a purple tincture, ſuch as is drawn from that fiſh: I muſt own that a conjecture can ſcarce have a more ſlight foundation: however I took ſome of the grains immediately from the ſtones to which they were adherent, and making uſe of the firſt linnen and the leaſt coloured that preſented itſelf at the inſtant, I ſqueezed ſome of the juice upon the ruffles of my ſhirt; they appeared to me to be a little ſoiled by it; but I ſaw no other colour than a yellowiſh caſt, which I diſcerned with difficulty in certain places. Divers objects that drew my attention made me forget what I had done to my ruffles; I thought no more of them, when caſting my eyes by chance upon my ruffles a little while after, I was ſtruck with an agreeable ſurpriſe; I ſaw a very beautiful purple colour on *thoſe* places where the grains had been bruiſed. I could ſcarce believe a change ſo quick and ſo great; I repeated the trial by wetting my ruffles with the juice of ſome others that I pickt out with care, as the whiteſt or rather leaſt yellow; I ſqueezed them on places of my ruffles untouched before, which at firſt gave no colour that approached to red; yet I had ſcarce fixt my eyes on them two or three minutes,

minutes, but I ſaw them take a purple colour like *that* which the former grains had given; this purple colour is at leaſt as beautiful as what is drawn from the buccinum: my only fear was that it would be more fading, and conſequently leſs proper for dying. The ſea water ſerved immediately to clear up this point, I waſhed my ruffles in it as much as I could, without perceiving any alteration in their new colour, and they have preſerved it, notwithſtanding a great number of waſhings through which they have paſſed *ſince*; I muſt own, however, that each waſhing weakens it, although it doth not entirely remove it.

The reader will imagine that my curioſity was rowſed at this new diſcovery, and that I gathered up as many of theſe grains as I could before the tide came in, in order to make experiments at home. No ſooner was I got into my cloſet than I began to ſqueeze out the juice of ſome of them upon different pieces of linnen; but the ſucceſs did not anſwer my expectation, and I had as much reaſon now to be ſurprized at the failure, as before at the production of ſo ſudden a colour. In leſs than two or three minutes my linnen had paſſed from white to red in my firſt experiments; and now at the end of two or three hours I did not perceive the leaſt alteration. I knew that there was nothing which brought out the colour of the liquor

of

of buccinum ſo ſpeedily as the heat of the ſun or fire; but I recollected that there had been no ſun-ſhine at the time of my experiments on the ſea ſhore. However to be ſatisfied on this head, as there was no ſun-ſhine at preſent, I placed the linnen that had been wetted with the liquor of the grains very near the fire; they dried there, but without any change of colour.

Confounded, and not knowing what elſe to have recourſe to, I was preparing to return to the ſea ſide, to ſee if the grains I had brought from thence would reſume their power, or had entirely loſt it by being tranſported; when caſting my eyes by chance towards the window of my room, I perceived ſome ſpots of a beautiful red, ſuch as I was ſeeking; theſe ſpots were on the plaſtering of the wall of the window: the liquor of ſome grains, that I had ſqueezed near the window, had ſpurted on the wall, and *there* taken the colour that had ſlipt away from me. In purſuing this Proteus, my firſt notion at the ſight of this colour in the window, was that the alkali of the lime contributed to its production, and that my ruffles might retain, from their waſhing, enough of that ſalt to produce the effect. In order to aſſure myſelf concerning it, I took off a piece of the plaſtering from the window, and having put it on my table I wetted it with the liquor of the grains; but it only

ſerved to confound my reaſoning, and to baulk my expectation, for no colour appeared. At length I went and ſqueezed ſome grains on the plaſtering at the window; ſcarce had I continued a few minutes to obſerve what effect the liquor would produce, but I ſaw the purple colour appear. This led me to conjecture that if I placed the pieces of linnen that I had wetted with the liquor near the window, *they* alſo might turn red like the plaſtering.

This conjecture ſoon ripened into certainty, for no ſooner had I placed the linnen on the window, than I ſaw it tinged with a beautiful purple.

The cauſe of ſo ſudden a change was then eaſy to perceive; that ſince my linnen had continued to preſerve the white colour of the liquor with which it was wetted, whilſt I left it in the middle of my chamber, and on the contrary had taken a purple, when I put it in the window, this effect could be attributed only to the different manner in which the air acted upon it in theſe different circumſtances. Who could have deviſed that a little more or a little leſs circulation of air ſhould have produced ſo ſuddenly ſuch a diverſity of effects? For it muſt be obſerved likewiſe that the caſements of the chamber were all the time open: all the experiments I made afterwards confirmed this opinion that it was the air alone which cauſed the

the difference. It happened even when I expoſed pieces of linnen wetted to the open air, in the midſt of a court, and, to prevent the wind from blowing them away, put ſome little ſtones upon the corners, that all the corners, on which the ſtones reſted, did not change their colour at all, whilſt the reſt of the linnen took a very beautiful purple; the effect of a greater or a leſs impreſſion of the air ſhewed itſelf in a very ſenſible manner, when I expoſed ſome of this liquor in a glaſs or tea-cup on a place where the wind blowed freely; all the upper ſurface was coloured red, whilſt the inferior remained whitiſh.

N. B. *I cannot forbear throwing in a query, how far theſe experiments and obſervations may tend to give light into the nature of ſanguification in animals, and to make it probable that air mixes with the blood in the lungs? An uſeful reflection may be drawn likewiſe from the great diverſity of effects occaſioned by a little more or a little leſs air, which may ſolve many difficulties in the animal œconomy, and ſhew the miſchief of a cloſer, and the benefit of a more open air, even in ſuch ſmall degrees as one ſhould otherwiſe have thought inconſiderable.*

Whatever experiments I have tried, ſays Mr. De Reaumur, they have not been ſuc-

ceſsful enough to diſcover to me what thoſe little grains are: I make no doubt, however, that they are the eggs or ſpawn of ſome fiſh, but in vain have I attempted to find what *ſpecies* of fiſh produces them; they are all of ſuch a determinate bigneſs as the eggs of the ſame ſpecies ſhould naturally be; and in whatever ſeaſon you obſerve them, you find no change either in their length or thickneſs, which hinders one from conceiving them any ways vegetable.

As the buccinum appears commonly aſſembled in great numbers round about theſe eggs, it gave me great inclination to believe them the ſpawn of that fiſh; yet they appear ſomewhat too big to come from ſo little a fiſh: all the experiments I have made have not been able to clear up that point. In vain have I diſſected abundance of buccina at different times; I could never find ſuch eggs in their body. I have ſhut up buccina in earthen pots put into the ſea, in ſuch manner that the water had a free paſſage, and yet no ſuch eggs or ſpawn was to be found there, which I think muſt have happened, if it had truly been their ſpawn.

This, however, is certain, that thoſe grains are either the ſpawn, or the nouriſhment of the buccina, which they are extremely fond of; for otherwiſe why ſhould they aſſemble ſo much about thoſe grains? But uncertain muſt we remain whether the buccinum

buccinum gives the purple liquor to theſe grains, or on the contrary derives its own purple from them.

I have ſought with great care in the writers of natural hiſtory, and particularly in Ariſtotle and Pliny, to ſee if I could find any thing that could give light in this ſubject, but I have not found any paſſage where they have ſpoken clearly of it.

One ſingle paſſage in Ariſtotle appeared to me to have ſome relation to it, but having well conſidered the whole I remain uncertain whether Ariſtotle meant to ſpeak of thoſe grains that are the ſubject of our enquiry. This paſſage is at the end of the 13th chapter of the 6th book of the hiſtory of animals, and I will give it in the Latin verſion of Gaza.

Defertur ex ponto in helleſpontum purgamentum quoddam illius maris, quod algæ nomine phycos appellant, colore pallidum, florem algæ id eſſe alii volunt, atq; ex eo fucariam algam provenire: fit hoc æſtatis initio, eoq; tùm piſciculi tùm oſtreæ hujus loci aluntur; purpuram quoq; ſuum florem hinc trahere, nonnulli exiſtimant.

There are in reality in this paſſage ſeveral things which ſeem to agree to the grains we are ſpeaking of. The pale colour he gives to that ſpecies of fucus is the ſame as of our grains; the inhabitants of the ſea coaſt (for inſtead of *alii* in the Latin, the Greek text

gives it the *fiſhermen)* conſider it as the flower of the fucus, from whence the alga afterwards comes; which is very conformable to what our fiſhermen think, who take it for the grains or ſeed of the ſame plant.

Laſtly, he adds that the purple-fiſh derive their liquor from it; for the expreſſion *flos purpuræ* in Ariſtotle means that liquor. Now this agrees well likewiſe with our grains from which we may imagine the buccinum derives its liquor. We have given their reſemblances, and ſhall now conſider their diſparities:

Firſt, he ſays *ſit hoc æſtatis initio*, whereas our grains do not begin to appear until the end of ſummer, or rather the beginning of autumn. Next, theſe grains are ſo adherent to the ſtones that they are not eaſily ſeparated. We ſcarce ever find any removed from the place where they were naturally faſtened. Laſtly, all that Ariſtotle ſays in this paſſage, may very well be underſtood of ſome little ſpecies of the *fucus tinctorius*. Shell fiſh feed on it; and it being proper to give the dye, it was natural enough to think that the purple-fiſh derived their colour from thence.

It is eaſy to conceive that the liquor of theſe grains might have been ſqueezed out in a manner infinitely more commodious than what the ancients made uſe of in order to get the liquor of the buccinum; all the labour requiſite is to gather up the grains, of which there is great plenty; and after having

ing waſhed them in the ſea water to clean away the filth, which might otherwiſe by its mixture alter the purple colour, to put them under little preſſes, and ſqueeze out all their liquor in an inſtant. The liquor of the buccinum, on the contrary, could not be drawn out without employing a great deal of time.

Memoirs 1711, *pag.* 169.

The ſurpriſing production of ſoles from ſhrimps or prawns.

It is commonly thought on the coaſts of France and England, that ſoles are produced from a kind of ſhrimps or prawns. Nothing can have more the air of a popular and abſurd ſtory; *to compare ſmall things to great, it ſurpaſſes in extravagance the fabled birth of Bacchus from the thigh of Jupiter.* Yet as it is poſſible, by diſdaining too much ſuch improbable ſtories, to be ſometimes the dupe of our own contempt, Mr. Deſlandes was willing to examine whether there was the leaſt foundation for ſuch a ſtory, and hath diſcovered this piece of philoſophy of fiſhermen and the common people to be founded on reaſon.

He got a large quantity of prawns to be taken, and put them into a tub, of about 3 feet diameter, full of ſea water. At the end of 12 or 13 days he ſaw there 8 or 10 little ſoles, which grew by degrees. He repeated the experiment ſeveral times, and always found little ſoles. This was enough to juſtify

the notion of the people. Encouraged by this he afterwards put ſome ſoles together with ſome prawns in the ſame tub, and in another tub he put ſoles alone; it was in the month of April; and in both tubs the ſoles ſpawned in perfection, but there did not appear any little ſoles but in that tub where the prawns were.

It is clear therefore that ſhrimps or prawns are of ſome uſe towards the production of ſoles. Mr. Deſlandes hath obſerved, that when they are juſt taken out of the ſea, you may diſcern between their feet ſeveral little bladders of unequal ſize and in great numbers, which are ſtrongly faſtened to their ſtomach by a gluiſh liquor with which they are ſmeared. If you take off theſe bladders, and open them gently, you ſee there a ſort of embryos which have all the appearance of ſoles, particularly when looked at with a microſcope.

Now here lies the myſtery; theſe are the eggs or ſpawn of ſoles, which in order to be hatched, have need of being faſtened to the ſhrimps or prawns, in like manner as many plants and animals, which do not grow nor receive nouriſhment but upon other plants and other animals. The prawns therefore are in ſome ſort the foſter-mothers of ſoles during their firſt infancy, and this hath occaſioned them to paſs for their real mothers.

Hiſtory 1722, *pag.* 19.

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The learned are as much on their guard againſt the marvellous, as the vulgar give willingly into it. This is a prudent diſpoſition of the learned, but yet they ought never to deny the moſt ſurpriſing facts, in the ſame manner as the people receive them; that is to ſay, without having examined them with ſufficient care.

The wonders in crawfiſh, lobſters, crabs, &c.

Thoſe that frequent the ſhores of rivers or the ſea aſſure us, that when crawfiſh, lobſters, crabs, &c. have by ſome accident loſt one of their great legs, in the place of the leg loſt there grows out another. What ſeems to prove it is, that one finds crawfiſh, for example, which have one leg much ſhorter than the other. Notwithſtanding the probability ariſing from thence, the learned have without heſitation ranked this fact of a *reproduction* amidſt the number of fables, and have attributed the inequality of the ſame pair of legs to an original defect of conformation.

I was induced, ſays Mr. De Reaumur, to examine into the truth of this affair, and in order to clear it up had need only to confine in veſſels theſe animals after having cut off a leg, to ſee what would be the reſult.

I took ſome crawfiſh from which I cut off a leg, and ſhut them up in covered boats that the fiſhermen call *well-boats* or *trunks*, where they preſerve fiſh alive. As I did not let them want food, I had reaſon to think that

I ſhould *here* find, if at all, that reproduction I was in queſt of. My hope was not deceived; for at the end of ſome months I ſaw new legs occupying the place of the old ones, which I had taken off; except in ſize, they were perfectly like the former, had the ſame figure in all their parts, the ſame articulations, the ſame movements. Such a ſource of reproduction doth not perhaps leſs excite our envy than admiration; if in the place of a leg or arm loſt by *us* there ſhot forth another, we ſhould more willingly embrace the profeſſion of arms.

Nature furniſhes us in theſe fiſh with a fair opportunity of admiring the divine providence. She hath given to craw-fiſh, and all the animals of that kind, long legs, which are to them in the place of hands; ſhe hath made them big towards their extremity, and ſlender at their origin; as it naturally follows from this ſtructure, and likewiſe from the ſhell with which they are covered, that they are eaſily broken near one of their articulations, ſhe hath put theſe animals in a condition to repair a loſs, which they are expoſed to ſuffer even at the time they exert thoſe motions only that the wants of life require.

The time neceſſary for the production of new legs is not determinate; it is one of the inſtances in which this kind of generation differs from that of the fœtus. Theſe legs ſhoot forth and grow more or leſs quick, like

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plants, according as the ſeaſon is more or leſs favourable; the hotteſt days advance moſt their formation and increaſe. Divers other circumſtances render likewiſe the reproduction more quick or ſlow; one of the moſt eſſential circumſtances is the place where the leg hath been broken: to make myſelf more clearly underſtood it muſt be obſerved, that each large leg hath five ſimilar joints; now if you break off the leg near the fourth joint from the extremity, it will *then* be reproduced with the greateſt eaſe: and it is worthy of remark that the legs naturally break in that place; unleſs they are broken with deſign, you do not ſee them broke near any of the other articulations: it is not in the joint itſelf that the leg breaks; the joint is covered with a ſtrong and flexible membrane: but the ſcale which is near the fourth joint, between that and the third, is compoſed of ſeveral different pieces, which is evident from two and ſometimes three ſutures that one perceives in that place. Now it is in theſe ſutures, and particularly in the middle one, that the leg breaks; the pieces of ſcale are there but weakly faſtened together, they do not apparently lock one into another; ſo that the leg may be broke by a very ſmall force. If you cut off a leg at the firſt, ſecond, or third joint, and go to examine the craw-fiſh ſome few days after, you will ſee with ſurpriſe that the legs, which you had

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cut at thoſe joints, are all broken off at the future near the fourth joint; as if the craw-fiſh, well knowing that their legs ſhoot forth much faſter when they are broke in *this place* than *elſewhere*, had the prudence to break them *there* of themſelves. However I have ſeveral times ſeen parts of legs, which had been cut off near the firſt, ſecond, and third joint, reproduced from thoſe ſtumps; but then they grew out much ſlower than thoſe which have been broken at the future near the fourth joint; and moſt commonly, as we have mentioned, you will find the craw-fiſh have broke them off *there* anew.

We have already ſaid that the ſummer is the moſt favourable time for this reproduction; *then* it is performed in four or five weeks, whereas it will ſcarce be completed in eight or nine months in the other ſeaſons of the year: the little legs likewiſe, and the horns will be reproduced in the ſame manner. I was willing to know if the tail would be reproduced as well as the legs; for this purpoſe I cut off tails in different places, but there never came out parts reſembling *thoſe* I took away; the craw-fiſh always died a few days after: if you take off a claw or a part of a claw, the whole or the part returns again in the ſame manner as the legs. Nature reſtores to the animal preciſely what it hath loſt, but makes no addition.

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This reproduction of legs affords ſtrong objections againſt a very ingenious notion, which is ſupported by abundance of experiments; I mean the notion of thoſe who think that all animals ariſe from thoſe little animalcula, which are perceived, in thouſands, *in ſemine maſculo*. The legs, or parts of legs of crawfiſh do not ſurely ariſe from an animalcule, or a part of an animalcule: the formation of ſuch an organical part as the leg, or the formation of the whole animal machine, are in the main equally difficult. If the leg be truly produced anew, why may not the whole animal be produced anew likewiſe? In a word, the leg, or part of a leg, doth not probably come from a leg, or a part, that was pre-exiſtent, and indued with all the motions, of which the leg is capable, ever ſince the beginning of the world: why then ſhould we be deſirous of making the whole craw-fiſh ariſe from an animal, that hath been in life and motion ever ſince the great creation? The one ſurely is no more neceſſary than the other.

The reaſon why a leg is reproduced ſo faſt in ſummer, and ſo ſlow in winter, I take to be this: the craw-fiſh, although carnivorous, and voracious animals, eat little or ſcarce at all, during ſeven or eight months of the year, and conſequently are not in a condition to furniſh the juices neceſſary for new productions; it is ſufficient that they

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are able to ſupport life. During the winter they aſſemble ſeveral together in the ſame hole, and rarely quit it before the ſpring; then they begin to ſtir abroad, yet do not attempt much to catch fiſh or inſects from the water, until the heat of the weather becomes very ſenſible.

The cloſe texture of the ſhell, with which they are covered, hinders probably the perſpiration from being greater, than what may be ſupplied by the nouriſhment they derive from ſimple water.

But as ſoon as they take more ſolid food, they have not only the nouriſhing juices that their preſervation and growth require; they have enough likewiſe to furniſh out the new productions.

It is probably the *ſurpluſage* of this nouriſhing juice, which is employed every year to form a new ſhell to each craw-fiſh; there is not *one* but ſtrips off his ancient covering, ſome indeed ſooner and others later, but none before the month of May, nor after the month of September; by which it is clear that they never change their ſhells 'till after they have begun to eat ſolid food. Before they quit their covering, they ceaſe to take any ſolid food for ſome days, as if they found themſelves too full, and too much ſtraitened by their ancient ſhell; or as if they knew that a few days of abſtinence, by diminiſhing their fleſh, would more eaſily ſeparate the

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ancient ſhell from *that* which is formed underneath; if we may be allowed to give the name of a ſhell to a membrane, that is indeed thick, but as yet very ſoft.

It is eaſy to foreſee this change two or three days before it happens. If you preſs with a finger either the large table or plate of ſcale that covers the head, and a part of the back of the animal, or ſome of the little plates that cover the tail, you perceive them give way; being no longer ſupported by the fleſh, they yield and ſink down at a very light preſſure. The ſoftneſs of the ſhell at a certain ſeaſon, and the finding of craw-fiſh ſhells, which are entirely empty, ſeem ſufficiently to prove that the craw-fiſh do actually diveſt themſelves of their ſhells; but to ſpeak the truth, theſe obſervations do not *demonſtrate* it, nor take away all matter of reply: it might be ſuppoſed that there are craw-fiſh of different ſpecies; that it is natural to ſome to have an hard ſhell, and to others to be veſted only with a ſoft ſkin; that there are craw-fiſh which reſemble certain fruits; that we ſee almonds, for example, whoſe ſhell cannot be broken but by an hammer, and others again whoſe ſhell breaks with the preſſure of a finger. Perhaps it may be ſaid that there are certain diſeaſes, which ſoften the ſhells of craw-fiſh.

With regard to the empty ſhells one meets with, it may be ſaid, that they are the *remains*

mains of craw-fiſh, which have been the prey of other animals.

The fact is ſurpriſing enough to make one have recourſe to all the reaſons that can bring it into doubt. It is ſcarce conceivable that an animal ſhould diveſt itſelf not only of its ſhell, but likewiſe of all that it hath cartilaginous, bony, or analogous to bone; in a word of its whole *frame*; that a living animal ſhould make as I may ſay its own ſkeleton, for ſuch in reality is the empty ſhell that one finds.

Therefore to eſtabliſh the fact, I have not truſted to the probabilities I have beforementioned, nor to the unanimous report of fiſhermen; but have believed only my own eyes. Having picked out ſome craw-fiſh which appeared ready to moult, I put them in my cloſet into veſſels full of water; and *there* having them continually before my eyes, I could at my eaſe ſee them quit their ancient ſhell. I have likewiſe obſerved them in the river itſelf; I ranged ſeveral pots full of holes along the brink of an arm of the river Marne, which runs by ſide my garden. In each pot I put ſeveral craw-fiſh, they had *there* continually freſh water; and in conſequence of that have diveſted themſelves much ſooner than thoſe which I had conveyed into my cloſet; for it is too oppreſſive to the animal to be incommoded at a time that he is already ſick, and hath need of his whole ſtrength.

ſtrength. I ſaw however, the ſame preliminaries *there* as in my cloſet; ſome hours before the crawfiſh is ready to ſtrip himſelf, he rubs his legs one againſt another, without changing place, ſtirs them likewiſe each one ſeparately, throws himſelf along on his back, turns in his tail, and next extends it, agitates his horns, in ſhort exerts all thoſe motions that tend to give each of thoſe parts a little looſeneſs in their *caſe*.

After theſe preparations he ſwells and puffs up his body more than it is uſually; then the *firſt* of the tables that covers the tail, appears disjoined a little from the large table that covers the head, and may be called the helmet, although it covers likewiſe the ſtomach, and other internal parts. The membrane that unites this helmet with the firſt table breaks, and the body of the craw-fiſh appears; the body is eaſy to be diſtinguiſhed, it is of a dark brown, whereas the old ſhell inclines to a greeniſh brown. I ſhall mention by the way that it is by this laſt colour that one knows *thoſe* which have not yet moulted, and that the more they are of a brown and dirty green, the nearer they are to moulting.

They do not labour to diveſt themſelves of their ſhell immediately after the preceding rupture; they repoſe themſelves for ſome time; afterwards they begin again to agitate their legs, and all their other parts; at length the inſtant being come, when they think

themſelves able to get rid of a troubleſome covering, they ſwell and puff up the parts which are covered by the helmet: the helmet is raiſed up and ſeparated from thoſe parts where the legs take their riſe, it becomes looſe, the membrane which held it along the edges of the belly-part breaks, it continues only faſtened about the mouth; you ſee jutting out all round the helmet that part of the body which was before covered by it.

From the inſtant above-mentioned, to the time that the crawfiſh becomes entirely naked, there doth not paſs more than a quarter of an hour when it moults in the river; whereas in my cloſet they have been in labour for ſeveral hours: as they were *there* leſs at their eaſe, they have ſometimes given themſelves much more turmoil and motion, which hath occaſioned the helmet to be entirely detached, whereas in the river the helmet hath continued always faſtened about the mouth.

The helmet being lifted up to a certain degree, you ſee its edge ſpreading out from the firſt of the tables; the crawfiſh then draws his head backwards, and diſlodges his eyes from their *caſes*; at the ſame time he diſengages a little all the other parts of the fore-part of the head; the legs themſelves are drawn a little backwards, for there is but one pair that is articulated beyond the helmet.

helmet. At length after having ſwelled himſelf ſeveral ſucceſſive times, he draws his whole body backwards, and uncaſes either one of the great legs, or all the legs of one ſide, or a part of thoſe on one ſide; ſometimes thoſe of both ſides are diſengaged at the ſame time; for it doth not paſs in one uniform manner in all crawfiſh: the legs are ſometimes ſo difficult to be drawn out, ſo cloſely confined within their *caſe*, that they break off and remain behind. All this labour is extremely violent to the animal; I have found ſeveral die in the operation, and particularly the young ones.

At laſt, when the legs are diſengaged, the crawfiſh draws his head from beneath the helmet, and likewiſe the other parts which it covered, then darts himſelf forwards, extends ſuddenly his tail, and trails it out immediately; by this laſt motion he entirely quits his ancient *caſe*. From this laſt act of vigour he falls into a great weakneſs; all his legs are ſo ſoft that they bend, particularly in the places of their articulation, like wetted paper. Yet if you take up a crawfiſh immediately after he is come out of his ſhell, you perceive his body to be much harder than it is naturally: the hardneſs I ſpeak of doth not reſemble that of the ſhell; it is the entire maſs of fleſh which you perceive to be hard; the violent convulſions, into which the muſcles are thrown, are perhaps the cauſe of it.

I would obſerve that when the helmet is once raiſed up, and that the crawfiſh have begun to diſengage their legs, there is nothing capable of ſtopping them; I have often taken them out of the water in this ſtate, propoſing to myſelf to preſerve them half ſtripped; they completed their moulting in ſpite of me even in my hands. In vain have I preſſed the body, it did not hinder them from drawing their legs out of their ſheath, and even with vigour. In fine they were often diveſted entirely before I could have the time to put them into brandy or vinegar, where I deſigned to let them die; ſometimes even thoſe which I have put into theſe liquors, ſo different from water, have ſtill completed their moulting there.

We will now conſider the ſhell that the crawfiſh hath juſt quitted; you would take that ſhell itſelf for another crawfiſh; there is nothing wanting to it externally. The piece which we have named the helmet being no longer ſupported, and being adherent towards the mouth, falls back to its former place; there is no difference obſervable between this carcaſs and an intire crawfiſh.

There is in the animal's ſtripping off its ſhell one circumſtance that may appear inconceivable, which is, that a leg ſhould come out of its ſcaly *caſe*, and that the only opening of this *caſe*, through which the leg could paſs, ſhould be ſo ſmall that it is impoſſible

impoſſible the leg ſhould have paſſed: but in fact it hath not paſſed through *that* opening, but the caſe hath a ſlit that is not diſcernible along its whole length, and is compoſed of two pieces ſo exactly joined, that they appear abſolutely but one: this ſlit ſpreads itſelf open a little to give paſſage to the leg, and in a moment cloſes again ſo *harmoniouſly* that the ſlit diſappears, as if nature had ſtudied to conceal the method ſhe employs to give paſſage to the leg. We have left the crawfiſh covered with a ſoft membrane alone, inſtead of an hard ſhell which he had before; he doth not continue long in this condition; I have ſometimes ſeen this membrane aſſume all the hardneſs of the ancient ſhell in 24 hours; in general it doth not aſſume that hardneſs under 2 or 3 days.

The little time that this ſhell requires to harden is likewiſe one of the ſingularities which the crawfiſh affords us: it is important to the animal to have an hard covering, without which he is expoſed to be the prey even of his own ſpecies; but, perhaps, the way that nature employs to give hardneſs to this ſhell is more ſingular ſtill; at leaſt if my conjectures prove true, and my obſervations can confirm what I think hath been advanced ſomewhere by Van Helmont.

I conſider the two ſtones ſituated in the ſtomach, and known under the name of crabs eyes, as the matter prepared and laid up *in*

ſtore, in order to ſerve when occaſion requires for hardening the ſhell. It is well known that thoſe ſorts of ſtones are not to be found at all times in the crawfiſh, you may trace their different degrees of growth by opening crawfiſh in different ſtates; but, perhaps, it is not known that the crawfiſh, in which thoſe ſtones are the largeſt, are the crawfiſh that are ready to moult; one finds them likewiſe in crawfiſh that are diſſected immediately after moulting; but if one day after the moulting you open the crawfiſh, you find the ſtones much ſmaller than could be expected; and laſtly, if you open the crawfiſh when its ſhell hath aſſumed all the hardneſs that is natural to it, the two ſtones no longer appear. Doth it not ſeem from thence that the one increaſes at the expence of the others? Since in proportion as the ſhell hardens, the ſtones diminiſh in ſize, and are no longer found when the ſhell is become hard; is it not reaſonable to think that the ſtones are diſſolved, and that the ſtony juice is carried and depoſited in the interſtices of the fibres of the ſkin or ſoft membrane? When the ſhell is arrived to a certain pitch of hardneſs, it permits no further entrance to thoſe ſtony parts, but the hardneſs ſtops at that degree. We do not perceive the ſhell to increaſe afterwards either in thickneſs, or in any other way; and, perhaps, it is from thence that the crawfiſh are conſtrained to caſt

caſt their ſhells every year: their habit becomes too ſhort and too ſtrait, it confines them and obliges them to quit it. This conjecture appears ſtrengthened by an obſervation I have made, and am aſſured of by a careful meaſuring, namely, that each part of a crawfiſh which hath lately moulted, is conſiderably larger every way than the caſe he hath quitted. It follows from hence, however, that the growth of a crawfiſh is extremely ſlow; for he grows only ſo much every year as the ſize of the new ſhell exceeds that of the old: the fiſhermen ſay that a crawfiſh, which is ſix or ſeven years old, is but of a moderate ſize.

We ſhall add before we conclude this article, that at the time the crawfiſh are ready to moult, there is in them another production much more remarkable than that of their ſhell; I mean the production of a new ſtomach; this fact hath been related many years ago by Van Helmont, but ſtood in need of a more certain teſtimony. Mr. Geoffroy junior hath given himſelf the trouble to examine into it, and hath really found a new ſtomach, which invelopes the old one; and what is more remarkable ſtill, he thinks it probable that the old ſtomach diſſolves, and becomes the firſt food which the new one digeſts.

Memoirs 1712, *pag.* 226, and *Memoirs* 1718, *pag.* 264.

Of bezoard ſtones, and pearls.

The firſt ſtones that bore the name of bezoard were brought from the eaſt: ſince the diſcovery of America there have come from thence ſtones, which being pretty much conformable to the firſt in ſtructure and in virtue, have likewiſe received the ſame name. There are likewiſe other ſtony ſubſtances, taken out of animals, and diſpoſed in lays, which have been named bezoard, by adding to them the name of the animal, from which they were taken; ſuch are the ſtones called *monkey bezoard*. Some taking the word bezoard in the ſignification of a counter-poiſon, have applied it indifferently to all ſubſtances that had this virtue; from thence it is that the name hath been given to chemical compoſitions, ſuch as the mineral bezoard, *&c.*

From the obſervation that the bezoard ſtone was diſpoſed in lays, the name hath been given to a ſort of figured ſtone, ſuch as is found in America, in different parts of the earth, and to which the ſame virtues are likewiſe attributed: we find this ſort of bezoard in Italy, Sicily, and even in France, in different places, and particularly in Languedoc.

We have mentioned in general the different ſubſtances known under the name of bezoard: but to ſpeak properly the bezoard is a ſtony ſubſtance, taken out of ſome animal, compoſed of ſeveral lays or coats, like

an onion, and which hath ſome virtue for reſiſting poiſon; the two principal ſpecies, as we have already ſaid, are the oriental and occidental. We know in general that this ſtone is found in the ſtomach of a kind of wild goat that browſes on aromatic plants. If Tavernier is to be believed, there are ſeveral of theſe ſtones found in the ſame animal, which may be known by the touch; the ſtones are of different figures and ſizes; there are ſome which have the ſhape of a kidney, or a bean, others are round, oblong, or of an irregular figure: the middle or center of the ſtone is commonly occupied by ſome hard body. I have found in the center of ſeveral that I have opened, ſtraws, hair, marcaſites, flints, gravelly ſubſtances, united together, and as hard as ſtone: I have likewiſe found talc, wood, ſtones reſembling cherry ſtones, nuts of various ſorts, and pieces of nuts.

I imagine that the ſubſtances included in the bezoard ſerve preciſely to indicate the manner in which it is produced: theſe ſolid and undigeſted bodies remaining in the ſtomach of the animal, may irritate the glands of it; and the lymph continually *thickening* together with the juices of the aromatic plants, that the animal feeds on, round thoſe bodies or buds as Tavernier calls them, may well be ſuppoſed to form the poliſhed lays.

I obſerve likewiſe that whatever body makes the center of this ſtone, the lays of it are ſo delicate and ſo well turned, that externally the ſtone hath the figure of the ſubſtance which is included within. Thus for example, if it be a ſtraw, the ſtone will be long; if a flint, it will keep that figure, *&c.* inſomuch that by the ſhape and weight one may gueſs what ſubſtance they contain.

Even the foſſile bezoard is formed in the ſame manner, having in the center ſome foreign body, round which the bezoardic ſtrata are formed and ranged: in the foſſile kind Bocconi hath obſerved nuts of different ſorts, flints, gravel ſtones, wood, metal, coal, *&c.* I have examined, ſays Mr. Geoffroy, ſome that are called *priapolites*, which grow in Languedoc; one of which, given to me by Mr. Bon, had the center occupied by a piece of rock cryſtal.

With regard to the animal bezoard we find ſeveral of thoſe ſtones in the ſtomach of one ſingle animal. Tavernier ſays, expreſsly, that ſix of thoſe goats, which were made a preſent of to him, had *in all* 17 bezoard ſtones, that might be felt outwardly and counted; and that the value of the animal increaſed in proportion to the number of ſtones that were felt. This agrees perfectly with what Cluſius relates of the animal that bears the occidental bezoard; he ſays that a friend he had at Peru, and who firſt diſcovered the occi-

dental bezoard, being desirous to know how those stones were formed in the body of these animals, dissected one, and found in the stomach a kind of pouch, where those stones were ranged in a row like the buttons on a coat.

These two passages are entirely opposite to what Pomet tells us, who pretends that there cannot be above one bezoard stone in the stomach of each animal. Indeed he assures us that he would not dare to contradict authors who have treated of it, if he had not in his hands a proof to justify his opinion: this affair is proper for our examination, and the more *so*, because no one that I know of hath publickly shewn the error of Pomet, on the pretended coat of the bezoard animal, which he says is one of the greatest curiosities that hath been seen for a long time in France.

This coat, says he, is about the bigness of a goose's egg, garnished outwardly with rough hair, short, and of a dun colour; which being cut open, you find *there* a thin and brown shell, which serves for a covering to another shell that is white, and hard as a bone, wherein is contained that stone to which the name of bezoard hath been given. *Pomet's treatise of drugs.*

Now this so singular a covering, of which he pretends to have made the discovery, is not at all a part of the animal which bears the bezoard;

bezoard; it is an exotic fruit, in which Pomet, or ſome quack, by whom he let himſelf be deceived, had inchaſed very dextrouſly a bezoard ſtone; this fraud was detected about a year ago. As I was examining with Mr. Vaillant, and Mr. De Juſſieu, demonſtrators of botany at the royal phyſic garden, this ſingular piece of the collection of Mr. Pomet, we were ſatisfied that this pretended covering could not be a part of any animal, and muſt be ſome fruit that was but little known; which was afterwards diſcovered to be true by Mr. Vaillant, who happened to have ſome of that ſort of fruit, and with eaſe made with it bezoards, together with their covering, entirely reſembling the bezoard ſo much valued by Mr. Pomet: the fruit grows on a ſort of palm-tree deſcribed by John Bauhin, which he calls *palma cuciofera*; it is deſcribed likewiſe by Theophraſtus: the tree grows in Egypt, Nubia, and Ethiopia. Cordus calls it *nux Indica minor*. It is of uſe to natural hiſtory to diſcover ſuch frauds.

I place in the rank of bezoard ſtones all ſuch ſubſtances as are formed by lays in the body of animals: pearls, which I rank of this number, deſerve it the more, as I have found ſome of them in certain ſhell-fiſh ſo like to the common bezoard, that it is difficult to diſtinguiſh them at the firſt ſight. Theſe pearls are produced in the ſhell-fiſh called *pinna marina, ſive aſtura Mathioli*, of which

which there is great plenty on the coaſt of Provence. The pearls that are found in this ſhell-fiſh are not all of the ſame water; ſome are, as I have ſaid, perfectly like bezoard ſtones; others are of the colour of coral and amber; others again of the colour of pearls, but more leaden; their ſhape is commonly that of a pear. All theſe different varieties of figure and colour do not hinder them from being of the ſame nature, ſince they are produced in the body of the ſame fiſh. That theſe pearls, as well as all others, are formed in the body of ſhell-fiſh in the ſame manner as the common bezoard in the body of thoſe goats that ſupply it, is not difficult to be proved, ſince by breaking them one finds them ſtreaked like certain bezoards, and formed round a kernel, which appears itſelf to be a little pearl. No one doubts but the oriental pearls are of the ſame nature as thoſe which are produced in other ſhell-fiſh, ſuch as in the oyſters we commonly eat, and the different ſorts of muſcles: all the difference between them ariſes only from their different water; but there is through all the ſame matter, and the ſame conſtruction, as is viſible from the different pearls one finds in the pinna marina; we ſhould, therefore, conſider pearls as true bezoard ſtones in reſpect of their nature, although they are not entirely *ſo* in reſpect of their virtue.

I ſhall not relate, ſays Mr. Reaumur, all that the ancients have delivered fabulous on the origin of pearls; natural philoſophy is too far advanced to require any proof that they are not produced by a celeſtial dew, notwithſtanding all the aſſertions of grave authors: thoſe who have taken them for the eggs of the fiſh where they are found do not deſerve our regard any more than the others. Mr. Geoffroy jun. ranks them amongſt bezoards, as he places in this claſs all ſtones formed in lays or ſtrata, which are ingendered in animals: it is certain that they cannot be conſidered but as other ſtones, which are formed in animals, ſuch as the ſtones of the kidnies, bladder, *&c.* They are probably likewiſe the effect of a diſeaſe of the fiſh; it is by no means ſurpriſing that an animal, that hath veſſels where there circulates a ſufficient quantity of ſtony juice to ſupply the building, thickening, and enlarging a ſhell, ſhould have enough likewiſe to form ſtones, if there ſhould happen an effuſion of the juice, deſtined for the growth of the ſhell, into ſome cavity of the body, or between its membranes. The ſtone is called a pearl, when the juice that hath over-flowed, and of which it is formed, is of a ſilver-colour water, approaching to that of mother of pearl; and its colour is likely to be ſuch in muſcles, oyſters, and other pearl ſhell-fiſh, whoſe very ſhell is of the colour of the *naker*.

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As air and aliment render the inhabitants of certain countries ſubject to certain diſeaſes, ſo undoubtedly the waters of ſeas and rivers, which fiſh reſpire and are nouriſhed by, cauſe in them many diſorders. From thence it is that nothing is more uncertain than the number of pearls found in thoſe ſhell-fiſh; in ſome of the pinnæ marinæ I have found none at all, in others I have found twenty. Muſcles of the ſame ſpecies have pearls in ſome rivers, and none at all in others; our oyſters would perhaps be more *precious*, if the waters of our ſeas were leſs wholſome.

Memoirs 1710, *pag.* 235. *Memoirs* 1712, *pag.* 202. *Memoirs* 1717, *pag.* 186.

A ſingular ſpecies of aquatic worm.

It is by no means ſurpriſing, ſays Mr. De Reaumur, that the worm I am going to give an account of ſhould have eſcaped the obſervers of nature; it is rare, very ſmall, and at firſt ſight offers nothing very ſingular; yet if contemplated a little it appears very well to deſerve our attention. The ſmalleſt inſects, and the largeſt animals, all come from the ſame hand, and bear equally the ſtamp and character of the great Creator.

This aquatic worm is no more than 7 or 8 lines in length, yet ſeems *itſelf alone* to compoſe a whole claſs; at leaſt we know not any claſs of animals, under which we can rank him; terreſtrial animals live on earth, aquatic in water, and the amphibious ſometimes

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on earth, and ſometimes in water. This animal hath the two extremities of its body aquatic, its head and tail being always in water, and the reſt of its body is always on land: to conceive how this is poſſible it is neceſſary to know its figure.

Like ſeveral inſects it is compoſed of different rings; it hath eleven between the head and tail; they are all pretty nearly ſpherical, and reſemble chaplets of beads ſtringed one to another. This inſect is almoſt always bent double, like a ſiphon; I mean that one of its parts is longer than the other, and that they are both almoſt parallel to each other, in ſuch manner that the head and tail are always near the one to the other; the part that goes from the bend to the tail is a little longer than that which goes from the ſame bend to the head: it is, however, the ſixth ring that is commonly in the middle of the bend; but the five rings towards the tail are larger than the five rings towards the head.

It is only the head and tail, and the ring the neareſt to the tail, that are conſtantly in water, the nine other rings, or at leaſt ſeven of the other rings are on land. The inſect keeps itſelf at the edge of ſtagnating waters; a water much agitated would not ſuit it; as ſoon as the water covers it a little more than we have mentioned, it finds itſelf uneaſy and removes; if on the contrary the water

water covers it leſs, it draws nearer to the water in an inſtant.

The worm having no more than 8 lines in length, it would not be eaſy to make this obſervation when it is at the edge of a large piece of water: ſo that it is by examining it in glaſſes or cups full of water, that I have been able to perceive what I have juſt related. I ſaw it always faſten itſelf to the ſides of the veſſel, in ſuch manner that its head and tail were in the water, and the reſt of its body was out. If by inclining the veſſel one way I obliged the water to cover it more, it removed itſelf as faſt as it was able: if by inclining the veſſel the contrary way I made the water leave it, it eagerly moved to get at the water which was wanting to it.

Moreover its *manner* of walking or creeping gave me occaſion to examine it more cloſely; it appeared to me to deſerve a place amongſt the progreſſive motions of aquatic animals, of which I have already given an account.

In its natural manner of moving, it is the middle of its body that advances forward *the firſt* toward the place where the animal would approach; that is to ſay, it is the ſixth ring that is the moſt forward, and ſeems to lead the reſt of the body, as it is the head that advances *firſt* in four-footed animals. In a word, whilſt it moves it continues bent in the ſhape of a ſiphon, and the middle ring begins the progreſſive motion. It is not

with a vermicular motion that it advances in this manner; it hath legs, very ſmall indeed, and whoſe ſhape can ſcarce be diſcerned without the aſſiſtance of a magnifying-glaſs: theſe legs are likewiſe one of its ſingularities. They are faſtened to its back, that is to ſay, to the part oppoſite to its belly; from whence it follows that it lies continually on the back, with its mouth turned upwards. This laſt circumſtance is not particular to it; we know ſome ſorts of flies and aquatic inſects which ſwim always on their back, becauſe they feed on inſects that ſwim or walk on the ſurface of the water: it is for the like reaſon that our inſect hath its mouth turned upwards. The mouth is ſurrounded by four little hooks, in the manner of other voracious inſects: from its middle there iſſue two little parts made in the ſhape of a tuft. The animal continually agitates theſe two little tufts, by lengthening them out, drawing them back again, and moving them from right to left. This little agitation keeps the water in a continued motion, and the little bodies that ſwim on the water are brought by this means from a diſtance, and ſucked into its mouth. This is the artifice it makes uſe of for its nouriſhment. When it hath drawn ſome little body that it thinks a ſuitable morſel, it advances the head, ſeizes it greedily, and ſwallows it. I have ſeen inſects taken in this manner

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which were of extreme ſmallneſs, and could not be ſeen but with an excellent glaſs. Altho' what it takes in this manner is very ſmall, yet it eats a great deal in proportion to its bigneſs, for there are continually little bodies entering into its mouth; we may well ſuppoſe that the greateſt part of them are not a ſuitable nouriſhment. Beſides its natural motion with its legs, it hath likewiſe a vermicular motion, which it rarely puts in uſe, and is always attended with difficulty. Its legs are ſo ſituated as to contribute to the motion we have already deſcribed, in which the middle advances forwards the *firſt*; but when it would move the head and tail the *firſt*, the legs can be of no ſervice to it. To move itſelf in this direction, it hath only a vermicular motion.

Nature affords us in this ſingle inſect theſe ſeveral ſubjects of admiration, that the tail and head live perpetually in water, whilſt the reſt of the body lives on land, that it hath legs on its back; that when it moves naturally it makes the middle of its body advance the *firſt*, as other animals do their head.

Memoirs 1714, *pag.* 203.

A remarkable talking dog.

Without ſuch a teſtimony as that of Mr. Leibnitz, we ſhould not dare to relate that near Zeitz in Miſnia there is a dog that talks. It is a countryman's dog of a very common

ſhape, and of a moderate ſize. A young child heard it utter ſome ſounds, which he thought reſembled ſome German words, and upon *this* took it into his head to teach it to ſpeak. The maſter, who had nothing better to do, ſpared no time nor pains; and luckily the pupil had ſuch diſpoſitions as it would be difficult to find again in any other. At length, after ſome years, the dog could pronounce about thirty words: of this number are *tea*, *coffee*, *chocolate*, *aſſembly*, words that are current in all modern languages without much variety. It is to be obſerved, that the dog was three years old when he was put to ſchool. He talks only by echo, that is to ſay, after his maſter hath pronounced a word; and he ſeems to repeat it by conſtraint, and againſt his inclination, altho' not beaten. It muſt be obſerved likewiſe, that Mr. Leibnitz ſaw and heard him.

Hiſtory 1715, *pag.* 3.

N. B. *The academy thought it neceſſary to premiſe an apology for relating the fact, and I think it neceſſary to adjoin one for extracting it. I am induced to it in order to give an hint to ſome ingenious perſon for exhibiting a talking dog, as we have lately had a chien ſçavant.*

On this occaſion I cannot omit mentioning what the academy hath obſerved in another place with regard to apes and monkies. The moſt

moſt perfect reſemblance they have to *man* conſiſts in the organs of voice; they have them *ſo* formed that the negroes have reaſon to ſay, without knowing it, that monkies could talk if they would; and that the greateſt part of philoſophers are to blame in ſuppoſing too generally, that the animals exert ſuch and ſuch actions, becauſe it happens that they have organs ſuited to them. It is not owing to the want of organs that apes and monkies do not articulate ſounds, and eſtabliſh a language amongſt themſelves; it is owing to the want of a ſufficient underſtanding; for one of the moſt admirable actions of *man* is that of ſpeaking.

Vide tom. 1. *anno* 1674, *pag.* 179.

On the prints of plants on certain ſtones, by Mr. De Juſſieu.

Mr. Luyd and Dr. Woodward have done honour to England in the diſcoveries they have made of abundance of ſtones, on which they have obſerved divers figured plants. Mr. Mill hath given us ſome obſervations on the like prints found in Saxony. Mr. Leibnitz had propoſed to himſelf the taſk of marking out all the places in Germany, where thoſe ancient footſteps of nature have been traced. And Mr. Scheuchzer hath ſet off Switzerland for its fruitfulneſs in theſe ſorts of figured plants, the types of which he ſuppoſes exiſted before the deluge.

France may boaſt her riches in theſe commodities as much as thoſe countries. Of this

I had the opportunity to be convinced in paſſing through the province of Lionois in my journey to Spain, as I went through the neighbourhood of St. Chaumont. The ſoil of that town as well as of St. Stephen in the foreſt, is well known to be abounding with pit-coal.

Recollecting that I had read in the letters of Mr Luyd that ſtones imprinted with the figures of plants are moſt commonly found in the neighbourhood of coal-pits, I was very attentive to the figure, colour, and ſtamps, of all the ſtones I met with near any of the pits of coal. My attention was ſeconded by ſome patterns that were put into my hands by one of my friends, diſtinguiſhed in that country for his taſte in natural hiſtory.

With this guide I had the pleaſure, even at the gate itſelf of St. Chaumont on the ſide of the little river Giés, to obſerve on the greateſt part of the ſtones that I collected, the impreſſions of a vaſt number of fragments of plants, ſo different from all the plants which are the natives of that country or even of the reſt of France, that I ſeemed to be herboriſing in a new world.

All theſe ſtones are *ſcaly*, and differ only in colour according as they lie nearer or more remote from the coal-pits; that is to ſay, thoſe which are the neareſt to a coal-pit are of a black and ſhining ſlate, in which they ſeem to partake more of the bituminous oil, which

which is the moſt eſſential principle of pit-coal: whereas thoſe that are more remote are of an aſh-coloured grey, which a mixture of particles of talc cauſes to appear ſometimes *bronzed* but moſt commonly *ſilvered*.

In both theſe ſorts of ſtones, of whatever colour they be, the ſtamps are always more highly coloured than the reſt, and diſtinguiſh themſelves particularly in the grey; ſometimes the ſtamps are the only part that appears covered with a light lay of bronze or ſilver; which is the effect of the facility that the vitriolic ſtreams have had of ſtopping in the furrows of theſe prints, rather than in the reſt of the ſurface of the ſtones.

They are different from the hard kind of dendritis, ſuch as agates or flints, and from the ſoft kind ſuch as razor ſtones and Florence ſtones, in *this*, that the figures, which are found in the ſtones juſt mentioned, penetrate quite through their whole thickneſs, like a foreign matter that hath inſinuated itſelf into them, as the late Mr. De la Faye hath very well obſerved; whereas in the ſtones of St. Chaumont the prints of the plants are only on the ſurface of the leaves of the ſtone, and in each leaf they are *all* different, and placed in divers directions. Hiſtory 1717, pag. 3.

The number of theſe leaves, the facility of ſeparating them, and the great variety of plants that I have ſeen impreſſed on them, made me conſider each of theſe ſtones as ſo many

many volumes of botany, which in one quarry compoſe, as I may ſay, the moſt ancient library in the world; and which are by ſo much the more curious, as moſt of theſe plants either exiſt no more, or if they ſtill exiſt they are in countries ſo remote, that we could never have had any knowledge of them without the diſcovery of theſe prints.

There would be only wanting, in order to perfect this collection of botany, to give names to the plants that are imprinted on theſe ſtones; even in *this* one might ſucceed by the rules that have been lately eſtabliſhed to determine the claſſes to which they belong: but as it is rare to find the plants intire, and one can diſcern only in general ſome fragments of branches, or ſome leaves, and as there are ſeveral which are croſſed by others of different ſpecies, it would be difficult to characteriſe or to deſcribe them with any exactneſs. We may however be aſſured that they are capillary plants, ceterachs, polypodies, adianthums, harts tongues, ſpleenwort, oſmunds, and the ſeveral ſpecies of fern, reſembling thoſe that the reverend father Plumier and Sir Hans Sloane have diſcovered in the iſlands of America, and ſuch as have been ſent from the Eaſt and Weſt-Indies to the Engliſh, and communicated to Plukenet for his collections of rare plants. One of the principal proofs that they are of this family is, that as *they* are the only plants which

which bear their fruits on the backside of their leaves, the deep impressions of their seeds are still distinguishable on some of these stones.

The multitude of differences in these plants is so great in the neighbourhood of St. Chaumont, that each place seems a new source of varieties.

Besides those prints of the leaves of capillary plants, I have likewise remarked some that appear to belong to palms and other foreign trees, together with some uncommon stalks and seeds; and upon scaling off some of the leaves of these stones, there has issued out a black dust, which was nothing else but the remains of a plant grown rotten, and inclosed between two strata, perhaps more than three thousand years ago.

There are in this affair three singularities which render it very remarkable; the first is, that we find not in the country any of the species of plants, whose prints are stamped upon these stones. This is a fact of which I informed myself by herborising with this view on the neighbouring mountains, and particularly on that of Pila in the Lionnois, distant from St. Chaumont about three leagues. The second is, that amidst this infinite number of leaves of different plants impress on the laminæ of these stones, we find none that are folded, but they are all at their full extent as if they had been glued on. The third

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ſingularity, more ſurpriſing than the other two, is that the two ſcaly laminæ of theſe ſtones repreſent each on their internal ſurfaces, by which they touch one another, only one ſingle face of a leaf, in relievo on one ſide, and *en creux* or hollow on the other; whereas in the uſual manner of conceiving ſuch impreſſions, it is natural to ſuppoſe that a leaf of a plant preſſed between two ſoft earths, muſt leave on the ſurface of the *one* the print of its upper part, and on the ſurface of the *other* the print of the lower.

From what we have mentioned theſe following obſervations muſt neceſſarily reſult; firſt, that theſe plants unknown in Europe can come only from the hot countries; becauſe if they reſemble more perfectly the American plants than any others, and the ſame ſpecies of plants to which they are related are found only in divers parts of the Indies, it follows by conſequence that they muſt have been brought either from thoſe countries, or from ſome other whoſe ſituation is pretty much the ſame.

Secondly, that as their print repreſents them extended and often lying in different directions one upon another, they could be impreſſed in this manner only, becauſe the water, on which they muſt have floated, kept them thus expanded.

Thirdly, that this water muſt undoubtedly have been the ſea-water; this is evident from

the ſhells of fiſh that are found in the neighbouring ſoils, ſhells that have not any reſemblance to freſh water ſhell-fiſh, but on the contrary, ſuch as are produced *ſome* on our own coaſts, and *others* on the moſt diſtant coaſts with reſpect to us.

Frequent experience of the viciſſitudes that happen to certain countries, whoſe lands are ſucceſſively over-flowed and deſerted by the ſea, ſhews us but too well how poſſible it is that the waters, which I ſuppoſe to have tranſported theſe plants, might have covered thoſe places of the Lionois; for without being obliged to have recourſe either to the univerſal deluge, or to earthquakes that have made great openings through which the waters of the ſea have been diſperſed, not to mention the dreadful tumblings of high and vaſt mountains, whoſe fall having occupied a great ſpace in the bed of the ſea hath thrown the water very far into land: without any ſuch ſuppoſitions, I ſay, there is no want of proofs, that the greateſt part of the lands, which have been inhabited beyond all regiſters of time, were originally covered by the waters of the ſea, which hath ſince by imperceptible degrees, and ſometimes ſuddenly, deſerted them.

The multitude of ſea-fiſh-ſhells, that are found ſtill intire almoſt in the center of mountains in Sicily and England, leave no room to doubt but thoſe iſlands have been

covered

covered with water; and we have no leſs proofs in France, that this part of Europe which we inhabit was formerly a bed of the ſea.

About an hundred and fifty years ago, Bernard Paliſſy a Frenchman, without any other ſtudies than his own obſervations made in ſeveral parts of the kingdom, began to inſinuate this doctrine in public conferences, which he held at Paris in the reign of Henry the third.

I could add to his obſervations ſome more proofs, which I have been able to collect from the voyages I have made to every part of this kingdom in gathering ſimples.

I had the honour, ſome years ago, to preſent to the academy ſome true madrepores ſtill adherent to their rocks, which I had pulled out of the earth at Chaumont, near Giſorre. They are ſtony plants that grow only at the bottom of the ſea, and which are therefore the moſt certain marks one can have, that this part of the continent compoſed formerly the baſon of the ſea.

Now upon ſuppoſition that theſe places have been once covered with water, it is eaſy to comprehend that impetuous waves driven from north to ſouth, and repelled from ſouth to north, either by the reſiſtance of high mountains or by violent hurricanes, have carried away with them the animals and plants of the ſouthern countries, from whence the

the waves have been driven back; and that in this reflux the waters having glided *into* and remained *within* creeks and baſons, formed by certain ranges of mountains, have *there* retained theſe light bodies, ſome intire, and others broken.

Thus we may conceive the foreign plants and ſhell-fiſh conveyed by the ſea water very far into our lands on the continent.

Memoirs 1718, *pag.* 287.

N. B. *I muſt own that this method of conveying plants from the iſlands of America to the continent of Europe over ſuch a vaſt expanſe of ſea, however pleaſing to the imagination, which delights in what is marvellous, and however fitted to ſolve the difficulties on this ſubject, ſeems to me too bold and daring to be confined within the bounds of probability.*

I cannot help obſerving likewiſe that Mr. De Juſſieu, at firſt diffident under what claſs to rank the plants with which theſe figured ſtones are marked, declaring it extremely difficult to characteriſe or even to give a deſcription of them, yet all of a ſudden pronounces them to be of American or Indian growth alone.

We find accounts in claſſical writers of plants and animals that were formerly the products of Greece and Italy, and are now no longer to be found in thoſe countries: why may not the ſame thing have happened with regard to theſe plants,

plants, especially as we may be allowed to include a much greater compass of time for the making such a change?

I beg leave to remark also that the bare outlines of a plant, intersected by others, as Mr. De Jussieu acknowledges, must make it extremely precarious and uncertain to assign its family.

A large district of country overwhelmed by sand.

In the neighbourhood of St. Pol-de Leon in the Lower Bretagne there is a district along the sea shore, which before the year 1666 was inhabited; but is now no longer habitable on account of a sand that covers it to the depth of above 20 feet, and which from year to year advances itself and gains upon the land. It hath gained more than six leagues since the year 1666, and is at present no more than half a league from St. Pol, so that in all probability that town must be abandoned. In the country that is overwhelmed, there are still seen some tops of steeples and chimnies, which rise out of this sea of sand.

It is the east or north east wind that increases this calamity; these winds raise the sand, which is very fine, and carry it in such great quantities and with such swiftness, that Mr. Deslandes, to whom the academy is obliged for this account, says that in walking there, whilst the wind was sweeping it, he was obliged from time to time to shake his hat and clothes, because he felt them grow heavy.

heavy. We ſhould remark by the way that there are in this ſand a great number of iron particles, diſcoverable by a knife that hath been touched by the loadſtone.

This unhappy diſtrict over-whelmed in ſo ſingular a manner, juſtifies what the ancients and moderns relate of tempeſts of ſand, that have deſtroyed whole cities and armies.

Hiſtory 1722, *pag.* 7.

A ſtorm of ſand.

On the 6th of April 1719, there fell in the Atlantic Ocean at 45 degrees of north latitude, and 322° 45′ of longitude, a ſtorm of ſand, which laſted from 10 o'clock at night to one o'clock in the afternoon of the next day. It was preceded by an *aurora borealis*; the wind was E. S. E. The captain of the ſhip, and all that were on board, have atteſted the fact to father Feüillée, to whom they gave ſome of the rain, if I may be allowed that expreſſion, which was eaſy to be kept: he hath ſent a ſmall parcel of it to the academy: it is a common ſand, and very fine. The neareſt land to the place ſpecified, is at 8 or 9 leagues diſtance. This cloud of ſand muſt have been conveyed therefore all that way through the air.

Hiſtory 1719, *pag.* 23.

Of thunder-bolt ſtones.

The thunder-bolt ſtones are real flints, that have the ſhape of a wedge or of an arrow-head. This figure occaſioned the ancient Greeks

Greeks to imagine that they were the arms of the thundering Jupiter, and that he darted them from his hands together with the thunder. This opinion hath paſſed or ſprung up of itſelf amongſt the people of the north, who finding theſe ſtones in great abundance in their own countries, have no leſs revered them. They even believe theſe ſtones, although proceeding from thunder, to be a preſervative againſt it; and it is with great difficulty that one can undeceive them even at preſent.

The Chineſe are not much within the ſphere of the contagion of theſe ideas, but yet have notions pretty much alike; and it is not eaſy to conceive how this ſuperſtition ſhould be ſo natural.

The origin of theſe ſtones is very evident, and very certain, from obſerving the *like* cut and faſhioned by the wild ſavages of America, in order to cleave wood, or to arm their arrows. They have no iron; but by rubbing ſtones very hard one againſt another, they make theſe ſorts of tools, which are abſolutely neceſſary to them, without grudging the time, of which they have indeed enough. Our continent was anciently inhabited by ſavages, and the ſame wants, the ſame ſcarcity of iron, inſpired them with the ſame induſtry. Afterwards theſe tools, which were become uſeleſs, were buried in great quantities under ground, and have been preſerved

there better than if they had been made of any metal, for the ruſt or verdigreaſe would perhaps have conſumed or disfigured them. Thus have they *fallen*, or more properly *riſen* into thunderbolts.

If the *figured ſtones* are monuments of great *natural* revolutions, *theſe* are a monument of a great *moral* revolution; and the comparing the new world with the ancient, ſerves equally to prove the changes that have been both in *man* and *nature*.

Hiſtory 1723, *pag.* 16.

An uſeful obſervation with reſpect to the mad dog.

When a perſon hath been bitten by a dog that is apprehended to be mad, it commonly happens that the dog is killed before one is aſſured of his condition, and the perſon bitten continues in a cruel uncertainty. Mr. Petit the ſurgeon hath an expedient for putting an end to this uneaſineſs. He rubs the throat, the teeth, and the gums of the dead dog with a piece of meat that hath been dreſs'd, taking care that there may be no blood to ſtain it, and then offers it to a living dog. If he refuſes it with crying and howling, the dead dog was certainly mad; but if the victuals have been well received and eaten, there is nothing to fear.

Hiſtory 1723, *pag.* 29.

Obſervations of communicating the magnetic virtue to workmens tools.

In the ſhops of lockſmiths, cutlers, and ironmongers, we find abundance of magnetic tools; almoſt all thoſe which theſe workmen make uſe of in cutting or piercing iron cold, as ſhears, punches, and broaches, take up filings of iron as ſoon as brought near them: there are even *ſome* that take up little nails, as well as they could do if they had been touched by a middling loadſtone; even files are often found magnetic. In a word *this* is peculiar to all tools that cut iron or ſteel.

However common this manner is of giving the magnetic virtue to ſteel, I do not know, ſays Mr. De Reaumur, that naturaliſts have hitherto examined it; in general we ſtudy too much natural philoſophy in our cloſets. This ſubject hath appeared to me to deſerve attention, and inſenſibly engaged me to make divers experiments.

I began by examining whether the tools I have mentioned derive their property of attracting iron from the iron itſelf, which they have cut or pierced, or whether they owe it to the temper of the ſteel. I cauſed different ſorts of tools to be made, and of different ſizes in each ſort; I got them tempered, and tried immediately after the tempering whether they were in a condition of attracting filings. I did not find one to which the tempering had given this property, at leaſt ſenſibly; I ſaw *ſome* indeed that barely lifted up

a grain or two of the filings, but perhaps they would have done *ſo* ſtill more before they were tempered.

Mr. Rohault relates, that having cauſed a long and ſlender piece of ſteel to be made red-hot, and having plunged it in water whilſt he held it perpendicular to the horizon, he found at each of its ends the virtue of one of the poles of the loadſtone, together with *that* of attracting very well the filings of iron. This experiment of Mr. Rohault engaged me to repeat it ſeveral times; but in vain have I plunged the ſteel in the circumſtances he deſcribes; I never found that the tempering gave it any ſenſible virtue of attracting; yet I doubt not but the piece of ſteel, of which Mr. Rohault ſpeaks, had the property he hath attributed to it, but probably it was not the *tempering* which occaſioned it. We ſhall diſcover preſently ſome circumſtances that might have produced it, which Mr. Rohault may be ſuppoſed not to attend to.

I lay it down for certain therefore, that ſteel tools, that have been but juſt tempered, have not yet the virtue of attracting iron; but one inſtant of time is ſufficient to communicate *that virtue* to them. Take a chiſel or a punch immediately after being tempered; place the edge of the one, or point of the other, on a piece of iron, no matter in what inclination; give a blow with the hammer at

the other end of the tool, you will find it ſufficient to give the magnetic virtue to the point or edge: preſent the point or edge to ſome filings of iron, it will attract them, and become quite briſtled with them. The having once cut iron is ſufficient to give the tool the power of attraction: from the firſt blow however the virtue is ſtill weak; it is increaſed by repeating the blow a ſecond time; and repetitions for a number of times will ſtill add to the new attractive force: but there is a limit, beyond which you would repeat in vain the operation, the virtue would be by no means increaſed by it. Thoſe which have been made uſe of for ſeveral months, are no more vigorous with this power, than thoſe which have been uſed but a day, nay even but an hour.

There are however divers circumſtances which contribute to augment this force: firſt the ſhape of the tools is a material circumſtance; a chiſel, whoſe edge is flat, receives the attractive power leſs ſtrongly than a punch whoſe point is conical. This may be remarked by comparing the effects of different tools, but I have made trial of it in a manner the leaſt equivocal. I cauſed the edge of a chiſel to be forged a ſecond time, and to be changed into a conical point, by which it attracted much more ſtrongly. It muſt be obſerved however, that *cæteris paribus*, the bigneſs of the tool contributes to increaſe its force.

Secondly,

Secondly, the moſt important circumſtance in a tool is to have a certain length; if it is extremely ſhort it is ſcarce attractive at all. I cauſed ſome punches to be forged that were not above an inch long, and were 8 or 9 lines in diameter: they attracted only ſome few grains of filings after having pierced a great deal of iron; whereas punches 3 or 4 inches long, and no more than a line, or a line and half in diameter, attracted little nails.

Whilſt I was trying to what degree it was poſſible to give this attractive virtue to tools by making them cut or pierce iron, I happened to be near an anvil, on which I placed the little pieces of iron, that ſerved to try the force of my magnetic tools. I put upon my hand one of the pieces that had been attracted on the anvil, and was ſurpriſed to find, that whilſt it was on my hand, the magnetic tool had not the ſame power to raiſe the iron; it could not even take up a piece that was much lighter than *thoſe*.

I then placed the pieces, that I wanted to attract, upon other bodies, ſuch as wood and paper, but the tool had no more hold of them *there* than when they were upon my hand; yet as ſoon as they were replaced on the anvil, the tool took up the largeſt of the pieces with the ſame eaſe as before. The ſame experiment, repeated and varied afterwards abundance of ways, proved to me that the magnetic tool had more force to attract

iron when placed on other iron, than to attract the ſame iron when placed on other bodies.

Another remarkable thing is, that the attractive vigour of a tool increaſes in proportion as the piece of iron, that ſerves for a ſupport to *that* you would attract, is bigger; what the magnetic tool hath raiſed from an anvil, it will not raiſe from a flat bar of iron. I have not been able to determine the exact proportion of the attractive force to the thickneſs of the ſupport, but I have obſerved often that the iron, which was lifted from an anvil, weighed more than double of *that* which was lifted from an ordinary bar.

Theſe experiments diſcover clearly a circulation of magnetic matter round iron; they force us to acknowledge that this metal, like the loadſtone, hath an atmoſphere, and conveys its virtue to other iron within its ſphere. As the magnetic tool raiſes a much heavier weight, when it is near a large maſs of iron, than when it is near a ſlight bar, the reaſon muſt be that the large maſs hath an atmoſphere that furniſhes more of the magnetic matter.

I took a piece of very pliant iron, and ſcrewed it in a vice between 4 and 5 inches from one of its ends; then taking with my two hands the longeſt end, which was above the vice, I bent it forwards and backwards ſeveral times in the ſame place; at laſt

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it broke in that place; but as it was very pliant, it did not break till it had ſuffered much torturing. As ſoon as it was broke, I preſented both the broken ends to ſome filings of iron, and ſaw them immediately covered with the filings; they would have attracted *leſs* from being touched with a weak loadſtone.

It muſt be obſerved that, *cæteris paribus*, the more the iron is ſoft and pliable, the more it ſuffers itſelf to be tortured before it breaks, but then the more vigorouſly are the broken ends endued with attractive virtue. Plated iron and brittle iron attract leſs ſtrongly; but in general I never found any iron, whoſe broken ends would not attract at leaſt ſome grains of filings, provided they are tried *the inſtant* they are broken. I add this laſt circumſtance, becauſe the attractive virtue grows weaker by degrees, and ſometimes doth not laſt longer than a day.

It is above all eſſential that the piece of iron which is broken ſhould have a certain length, without which you will find no ſenſible effect, as we have obſerved before with regard to tools. A ſingle example will be ſufficient on this head. Take a rod of iron about a foot long, break it pretty near the middle, and the two broken ends will attract very well the filings. If on the contrary you break ſuch a rod at an inch or two from one of its ends, the broken end of the ſhort piece

will not attract at all, whilſt the end of the long piece will attract very vigorouſly.

It muſt be remarked that it is the broken end alone that attracts, the other is not in the leaſt attractive.

I was willing to try if this virtue might not be increaſed by bending the iron rod forwards and backwards in different places, taken at divers diſtances from that end. For this purpoſe I choſe a rod of iron, about the thickneſs of a little finger, and near two feet and half in length. After having ſcrewed it in the vice, I bent it forwards and backwards ſeveral times in the ſame place, and at laſt broke it in that place, which was diſtant pretty near five inches from one of the extremities of the rod. By this diviſion I had two pieces, the *one* about five inches long, and the *other* about two feet and an inch; both theſe pieces were extremely attractive at their broken ends, ſo as to be able to raiſe from the anvil one of thoſe little nails called *tacks*. The longeſt of the two pieces I deſtined for purſuing my experiments; I ſcrewed it in the vice about an inch and half above the attracting end; I then bent it forwards and backwards ſeveral times ſo as not to break it. After having taken it from the vice, I tried whether its attractive virtue was by this means increaſed, and it appeared to me that it was *ſo*. I repeated the ſame contrivance in order to be aſſured of this augmentation, and

to ſee how far it would go. I continued in like manner to bend it forwards and backwards in eight different places between the attracting end and the middle of the rod. After every torture given to each new place of the rod, I tried whether there was an increaſe in the attractive force; I was ſatisfied there had not been one torture which did not give a freſh vigour: but the effect of all thoſe operations together, could admit of no doubt. They put the attracting end in a condition of raiſing four nails, equal each to *that* which it bore immediately after being broke.

Purſuing my experiments I bent the rod, at firſt towards the middle, afterwards between the middle and the non-attractive end. The effects that happened *then* will appear perhaps no leſs ſingular than the former. Theſe new tortures that I gave to the rod, did not ſtrengthen the attractive end; it ſeemed to me that they weakened it, and by repeated experiments I was convinced they did *ſo*. I tried immediately whether the *ſecond* end had not gained what the *firſt* had loſt, and I found in reality that the *ſecond* end began to raiſe the filings, which it had never done in the leaſt while the *firſt* was in its vigour. I continued to torment the rod in different places, approaching continually towards the ſecond end, and I ſaw, in proportion as I multiplied theſe operations, that its

its attractive force increaſed at the expence of *that* of the firſt end; it acquired enough force to raiſe the four nails that had been lifted by the firſt.

I was willing to ſee what would happen to a rod of iron that ſhould be tormented at firſt in the middle, and afterwards at equal diſtances on the one ſide and the other from the middle. The flexures and reflexions made in the middle, and in places not far diſtant from *thence*, gave no ſenſible attractive virtue to the ends; but when I bent the iron at about a third or a quarter of the diſtance between the middle and each end, then the one and the other end became attractive, but much leſs ſtrongly than if the flexures and reflexions had been of one ſide alone; they did not bear each a third or a quarter of what *one* of the ends would have borne, if the attractive virtue had been given to *it* ſingly.

As a little matter ſuffices to give iron the virtue of attracting, ſo a little matter is ſufficient likewiſe to deſtroy it. If after having given a certain degree of this virtue, you would multiply the inflexions, although you make them between the middle and the attracting end, you only weaken the force of its virtue; you at laſt entirely deſtroy it by multiplying them to a certain point.

Strokes with a hammer upon a tool not reſting on any other ſteel or iron, deprive it of

of the virtue of attracting, which it had acquired by cutting or piercing iron: they take it away likewiſe from iron that derives that virtue from inflexions. Too many inflexions produce at length the ſame effect as ſtrokes of the hammer. There is however a method of giving this magnetic virtue to iron by ſtrokes of a hammer:

A large bar of iron ſtruck hard in the middle, or near one of its edges, with a little hammer, acquires the attractive virtue at the oppoſite end, but yet leſs than the iron which hath been bent to and fro ſeveral times. This therefore is another method of giving the attractive power to iron without its touching a loadſtone; but it is one of the weakeſt.

In this weak manner of giving a magnetiſm to iron, there is however a circumſtance that deſerves to be remarked, which is that the whole end of the bar is not indued with magnetiſm, it never is *ſo* directly oppoſite to the places which have received the blows of the hammer. If the ſtrokes have fallen only on an half of the breadth of the bar, it will be only that half of the end, which correſponds to the part not ſuffering percuſſions, that becomes attractive. If care hath been taken that the ſtrokes ſhould fall exactly in the middle of the breadth of the bar, it will be the middle part alone of the end of the bar that is deſtitute of the virtue.

We mentioned at the firſt that all tools which cut iron *cold* become attractive; we ſhall add at preſent that, on the contrary, all tools which cut iron *hot* have not any attractive virtue. Moreover this virtue is deſtroyed in a magnetic tool, if it is made to cut iron red-hot from the fire.

I thought it neceſſary to try whether theſe ſame tools would not become attractive by cutting *other bodies* of different degrees of hardneſs: I tried ſhears that had cut a great deal of wood, others that had cut copper, and others that had cut ſtones harder than iron, upon filings of iron. I found in them all ſome ſmall degrees of attractive virtue, weaker however in ſuch as had only cut wood, than in thoſe which had cut copper.

If I am aſked how it comes to paſs that iron, with this abundance of magnetic matter, doth not produce the effects of the loadſtone? I anſwer becauſe it wants ſuch *determinate poles* as thoſe of the loadſtone; it is from its poles that the loadſtone derives its force. I conceive iron to be a kind of jumbled loadſtone, or to reſemble a maſs of the powder of loadſtone, in a word, that iron hath almoſt *every where* imperceptible poles. From thence it is eaſy to conceive that, altho' there may be round this metal and within it a great circulation of magnetic matter, yet it cannot have any great attractive power, becauſe

cauſe the ſtreams of magnetic virtue do not *concur* towards the ſame place.

Memoirs 1723, *pag.* 82.

N. B. *I have given the experiments and obſervations of Mr. De Reaumur diveſted of the theory, with which they are enveloped. This theory conſiſts in an imaginary notion of magnetic vortices, which he impels, directs, and diverts, juſt as it will ſuit the ſeveral phenomena of his experiments. An hypotheſis like this, altho' ingeniouſly forged, and pliable as the iron rods in his own experiments, doth not fall within the compaſs of my deſign, which is to exhibit nature, and not to tranſcribe romances.*

A remarkable loadſtone.

Mr. Carré read a letter he had received from Holland, wherein mention was made of a loadſtone, which weighs 11 ounces and raiſes 28 pounds of iron, that is to ſay, more than 40 times its own weight. It was to be ſold for 5000 livres.

Hiſtory 1702, *pag.* 18.

A new diſcovered property in iron.

It hath hitherto been thought that water alone dilates or increaſes in bulk by freezing, but Mr. De Reaumur hath diſcovered the ſame property in iron, which being melted expands itſelf in proportion as it cools and returns to a conſiſtence: the other metals on the

the contrary follow the general law of loſing ſomething of their dimenſions in proportion as they grow cold. A conſequence of this property in iron is, that iron is capable of being caſt in a mould in greater perfection than any other metal. The reaſon is evident, becauſe iron extending itſelf as it grows cold, will by conſequence inſinuate itſelf and be applied to the leaſt and fineſt ſtrokes in the mould with all the force of its extenſion, and muſt therefore receive very lively the impreſſions: whereas the contrary will happen in metals that contract themſelves, and withdraw continually from the fineſt ſtrokes of the mould, to which they were at the firſt inſtant applied. It is true indeed that iron is very rarely or ſcarce ever rendered ſo liquid as gold, ſilver, copper, tin, and lead. Notwithſtanding this diſadvantage caſt works in iron have a remarkable neatneſs and vivacity beyond thoſe of other metals.

A property ſo ſingular cannot be granted to iron without being proved in an inconteſtable manner. Now the point to be demonſtrated is this, that iron at the time the fire keeps it in fuſion is heavier than when it hath its ordinary hardneſs. In order to prove this I made a very fluid fuſion, and when it was *ſuch* I carefully ſkimmed the ſurface that there might not remain any film that could oppoſe the ſucceſs of the experiment. Into this fluid fuſion of iron I threw ſome pieces of

a ſolid caſt iron: if the liquid fuſion is heavier, hath leſs bulk than the ſolid caſt iron, it is certain that the latter muſt neceſſarily ſwim on the ſurface of the other, and riſe a little above it, as ice ſwims on the ſurface of water. Now this actually happened, in vain did I force down the pieces in the liquor, I ſaw them appear again and riſe a little above the ſurface.

I have likewiſe poured this metal *melted* into little cylindrical crucibles, which I exactly filled, taking care that I barely filled them by paſſing a plate of iron over the brims. I then left the liquor to congeal by degrees; the metal when it was become perfectly ſolid had riſen above the edges of the crucibles, and taken a convex ſurface, like to that of water which is frozen in veſſels.

When a fact is once known and aſcertained, one finds every moment proofs of it that were unheeded before. The greateſt part of moulds are compoſed of two frames that in general the founders ſqueeze in a preſs. After caſting the iron into the moulds, particularly when the work was thick, I have often obſerved that it was with great difficulty the founders were able to turn the nuts of the preſs; they uſed to be ſurprized at this, becauſe no ſuch thing happens to moulds that have been filled with copper.

The reaſon now appears evident, iron could not dilate itſelf without conſtraining the

mould againſt the preſs, much more than it was before the metal was caſt in.

We ſhall add a remark which is a conſequence of the preceding obſervation. *Caſt* works of lead, copper, gold and ſilver, are always found *leſs* than the models upon which they have been framed. The *like* works of iron are on the contrary *equal* to their models, or even exceed them ſomething.

Mr. De Reaumur made experiments likewiſe on zink, biſmuth, and antimony, and found that biſmuth and antimony muſt be ranked, with regard to this property, with iron and water.

Memoirs 1726, *pag.* 273.

Of the ſpecific differences of earths.

It is not the elementary earth of Ariſtotle and of many others, but an earth more known and familiar to us, that is the ſubject of our preſent enquiry. It would be a thing extremely deſirable, to acquire very diſtinct ideas of *firſt principles*; our knowledge would be more complete by it; but yet tho' we were poſſeſſed of ſuch knowledge, we ought not to have recourſe to it in order to determine the nature of the greateſt part of bodies that are the objects of our reſearches. To explain my meaning more clearly, I ſhall make uſe of a compariſon, ſomewhat ignoble indeed, but which ſeems to me very proper to ſhew, that we take a wrong method of inſtructing ourſelves when we paſs of a ſud-

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den to *remote* principles: this is unhappily the fault of chemiſtry, to which we owe however ſo many fine diſcoveries in natural philoſophy; it rarely ſhews us the *immediate* elements.

Let me bring from America or the Indies ſome one, whoſe paſſion hath always been natural philoſophy. I ſuppoſe him well verſed in all the proceſſes of chemiſtry, but very ignorant with reſpect to every thing that hath been contrived in Europe for flattering the taſte. I carry him to a paſtry-cook's, where I ſhew him cakes of all kinds, biſcuits, and all ſorts of tarts that are the workmanſhip of this art. I aſk of him what each of theſe compounds hath peculiar, what is their nature? If in order to anſwer my queſtion he hath recourſe to analyſing them, to diſtillations, and cohobations, *&c.* he may tell me that in ſuch cakes there are more oily parts, that others have more of ſalts, others again more of acids; he may even determine the proportion there is between the earthy parts, the ſulphurs, and the ſalts. But will he have given me any more an idea of the compoſitions, on which I have conſulted him, than of *thoſe* of ſome ſtones or plants, which treated in like manner would have given pretty much the like principles?

The true anſwer to my queſtion is, that ſuch a cake was made of nothing but common water, flour, and butter; that eggs are

in the compoſition of another; that yeaſt is uſed in this, ſugar in that, and pounded almonds in a third. Laſtly, it would be neceſſary to tell me that according to the manner in which the butter is mixed with the flour, it is made a puff-paſte or otherwiſe. If the paſtry-cook ſhews our philoſopher the materials that are employed and the manner they are employed in, he will ſee that he was to blame in having recourſe to quinteſſences, in order to diſcover the nature of theſe compoſitions.

When nature works in forming cakes of another kind, ſuch as ſtones, metals, and minerals, ſhe hath not always quinteſſences to employ, ſhe makes uſe of ſands, ſulphurs, bitumens, ſuch as ſhe finds. To introduce bitumens and ſulphurs into her works, ſhe no more analyſes them than the paſtry-cook analyſes his butter. In a word, it is with compounds that ſhe forms the greateſt part of the bodies, which are the objects of our conſideration.

In conformity to this manner of philoſophizing, Mr. De Reaumur hath examined *earth*, and finds by plain and certain expeririments, that *earth* ſucks in water in ſuch manner as to be increaſed in bulk, and reciprocally returns to its firſt ſize when it is become dry. *Sand* ſoaked with water as much as it is poſſible to be, doth not increaſe in bulk, nor diminiſh *ought* by growing dry.

From

From whence it follows evidently that water only fills the interſtices of the grains of ſand, but beſides this function in earth it penetrates more deeply into the grains, ſwells, and dilates them. Mere penetration, either into the interſtices, or into the cavites of the grains of earth, requires only weight, mobility, and fineneſs of particles in the water, but the *diſtenſion* of the grains requires indiſpenſibly ſome other force to make more water enter violently into the grains than they would naturally admit, and to ſurmount their reſiſtance to this diſtenſion. What is this force? It would be difficult to give a ſatisfactory anſwer; but it is undoubtedly the ſame as that which makes cords, that have imbibed water, when they come to contract themſelves from their diſtended ſtate, to raiſe enormous weights. It is that which makes wedges of dry wood, forcibly impelled into a rock, to cleave it aſunder, and detach from it large mill-ſtones, when they are diſtended with the water that they are made to ſuck up.

Sand, however finely pounded, is not the more open to water, it lets none enter but into the interſtices of its grains; and if it doth admit *ſome* perhaps into their little cavities, yet the water doth not extend them, ſince the total bulk of the ſand receives neither increaſe by the introduction of the water, nor diminution by its drying. It will happen ſometimes that the ſurface of the ſand will

even ſink a little by wetting, becauſe the water that hath penetrated may have changed the place of ſome grains of ſand and have carried them into ſpaces, which, tho' capable of lodging grains, had continued empty. *Earth* therefore is a ſort of ſpungy body, the particles of which are flexible and capable of extenſion; thoſe of *ſand* on the contrary are incapable of it by their ſtiffneſs.

Earth and ſand differ in another reſpect no leſs marked nor leſs deciſive. Earth ſoaked with water becomes ductile, it takes any form you have a mind to give it, as we ſee every day in the art of potters-ware: this quality correſponds to malleability in metals, and is probably owing to the ſame cauſe.

Now this property is not to be found in ſand, its parts are too ſtiff and too inflexible; and no doubt *this* is occaſioned by what we have already obſerved that it is not ſpungy like earth.

The more greaſy the earth is, the more ductile it will be: It is more or leſs greaſy either of itſelf by the more or leſs of a certain unctuouſneſs it contains, or by the different quantity of ſand with which it is mixed.

It might be thought that the ductility which is found in earth and not in ſand ariſes from *hence*, that the grains of earth are finer, as they commonly appear; it is certain indeed that fineneſs contributes to ductility, which conſiſts in *this*, that the ſmall parts ſlide eaſily

one

one upon another without loſing their connexion, or in taking new connexions: but Mr. De Reaumur hath made experiments which intirely deſtroy this notion.

With earth mixed with ſand, as it always is, and a ſufficient quantity of water, let there be made a muddy water, and leave it to ſettle in a veſſel; the groſſer ſand will ſink to the bottom at a certain time. By this operation, repeated in different ſucceſſive lotions, you will have the ſand and earth as ſeparate and pure as it is poſſible to be; the earth keeping ſuſpended whilſt the heavier ſand precipitates to the bottom. Pound this ſand extremely fine, reduce likewiſe to powder the pure earth, and you will find that theſe two powders mixt together and put in water will be equally ſuſpended. It follows therefore that the particles of the one and the other are of a ſufficient fineneſs to receive from the water an equal reſiſtance to their deſcent. Strictly ſpeaking we muſt allow a greater fineneſs in the particles of ſand than in thoſe of earth, as they are ſpecifically heavier and would deſcend if they had not a larger ſurface in proportion to their greater weight; now for *them* to have a greater ſurface in proportion to their weight, they muſt neceſſarily be much ſmaller, as geometricians well know. Yet a paſte made of this ſame powder of ſand will not be *ductile*, altho' one made of the powder of earth will really be *ſo*. The duc-

tility of earth therefore ariſes from a more intrinſick quality than the fineneſs of its grains, and by conſequence is proper to be a ſpecific character, to diſtinguiſh earth from ſand.

The ſpungineſs of earth may be the cauſe of its ductility; its grains not only penetrated and ſoftened by the water but ſwelled and extended, ſtretch themſelves out to claſp one the other, eaſily take on account of their ſuppleneſs the figures neceſſary to be adjuſted well together, and are for the ſame reaſon in a condition of changing eaſily thoſe figures in order to aſſume others. When earth, of which a paſte hath been made by ſoaking it with water, becomes dry, it will be more hard and compact, becauſe the new joinings of the particles, which the water hath produced, ſtill ſubſiſt even after evaporation. It is clear that the contrary muſt happen with regard to ſand.

From what we have obſerved with regard to earth, that it imbibes and is diſtended by water, we may likewiſe ſolve that well known and uſeful property of clay in holding water, ſo as not to let it paſs through. To this property we are indebted for ſo many ſprings and wells, which retain water for our uſes. A water that comes upon a dry clay finds grains ready to receive it, it may then find paſſages likewiſe between the grains, which permit it to advance to a certain depth. But immediately it haſtens to ſtop up the paſſages againſt

againſt itſelf. In proportion as it ſinks into the grains, it diſtends them, and forces them to be united more firm and compact together. Rohault, who probably did not attend enough to that property of earth, which we have been mentioning, attributes this effect to another cauſe, that ſeems at firſt view to be ſufficient. He imagines that water which penetrates clay, carries along with it the fineſt grains, that it depoſits them in the paſſages, and thus by little and little ſtops them up. But this notion is confuted by the following obſervation. If a piece of dry clay be wetted by the vapour alone of a moiſt air, it would be difficult to conceive that in this caſe there were any diſplacings and removals of the grains of earth; yet clay *thus* moiſtened would be capable of containing water, as well as *that* which hath been watered with a conſiderable quantity of that fluid.

This property in earth of expanding itſelf by moiſture and contracting by dryneſs is neceſſary to be attended to by the potter, whoſe veſſels are apt to crack in drying; by the gardener in raiſing his terraſſes; and by the engineer in making his ramparts and bulwarks, particularly with reſpect to the preſſure it occaſions againſt the lining wall.

Mr. De Reaumur obſerves ſeveral other differences that diſtinguiſh earths one from another. They differ with regard to colours, whether ſuch as they have naturally or ſuch

as they receive from the action of fire. Painters know how great the variety of colours is in earths, and it is a knowledge extremely uſeful to them. Some earths vitrify, others are calcined; and this likewiſe in different degrees. They are all conſidered as alkalines, and indeed acids act on them, but very differently. There are earths that receive from the weakeſt acids a violent impreſſion, whilſt others ſcarce receive any ſenſible effect from the ſtrongeſt.

There is another quality of earths that hath not been attended to, which is their *ſmell*. *That* which riſes after rain in the ſummer is well known; it comes from earth that hath ſcarce any ſmell but when it is wetted; and in this reſpect is the direct contrary to ſome other ſubſtances, ſuch as hair, horn, *&c.* which have a ſmell only from *burning*. The odours of different earths have differences from each other, like thoſe of flowers; and it is in like manner difficult and often impoſſible to characteriſe them. As it is the roſe alone that can convey the idea of its ſmell, ſo the odours of different earths can be known only by applying to them. Their ſmells in general are ſo many particular ſmells, yet there are ſome which have a reſemblance to other ſmells; for example there are earths whoſe odour approaches very near to *that* of pepper.

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The ſmell after rain is commonly attributed to the plants of woods or gardens where one chances to be walking. But if it be remarked that the moſt *arid* fields, and ſuch as are covered only with dry ſtubble or plants as dry, diffuſe at that time the like ſmell, it muſt be acknowledged that the earth alone is the ſource of that odour. It muſt be obſerved further, that the atmoſphere of the ſmells of earth is not very extenſive, the noſe muſt be pretty near, or it will not be perceived; which is another proof that it doth not ariſe from plants. I was willing to ſee if it was poſſible to exhauſt this odour from earth. I watered and dryed ſucceſſively little cakes of earth for more than a fortnight ſeveral times in a day: at the *laſt* of my experiments I did not perceive that any of my cakes gave a leſs odour, than at the *firſt*.

Hiſtory 1730, *pag.* 24. *Memoirs pag.* 243.

Of waſps, by M. De Reaumur.

We naturally intereſt ourſelves in the actions of animals that live in ſociety. Without being obſervers of nature, we love to hear of the good underſtanding amongſt *beavers*, who work by concert in building houſes of earth and wood, ſeveral ſtories high, in order to defend themſelves from inundations. The republics of *ants* and *bees* have gained eſteem and admiration through all ages. Societies are perhaps the firſt and moſt beautiful contrivance of human reaſon: we are ſurprized

to

to find that animals, which we deſpiſed, imitate us in this eſſential point; and after having vainly imagined ourſelves the only creatures indued with ſkill and foreſight, we are almoſt inclined to grant in ſome inſects a greater ſagacity than in ourſelves.

The *bees* are a pacific people that labour for our good, and in return we intereſt ourſelves for them; other inſects make war upon them, and conſequently excite our enmity and abhorrence: they have no enemies more dreaded than the waſps, who are not content with plundering them, but likewiſe devour them. The waſps, compared with the mild and well-policed republic of bees, appear to us a ſavage nation, a kind of hottentots; but we judge thus ill of them only for want of knowing them. We may apply to waſps, what hath been often obſerved with reſpect to a *diſtant* people, who have been thought *barbarians*, and are afterwards found to exceed *us* in many things. The republics of waſps are in nothing inferior to thoſe of bees; altho' more warlike, they are not leſs induſtrious nor leſs laborious. In ſhort, they are with reſpect to bees, what the ancient Spartans were with reſpect to the Athenians.

I ſhall not enter into a detail of the ſeveral ſpecies of waſps, that naturaliſts make mention of, but ſhall confine myſelf to the deſcription of their manners, to the diſcovery of

of their induſtry, and to relating the methods by which they people and govern their ſtates: I ſhall therefore ſay nothing of thoſe ſpecies that live recluſe like hermits. The object of my enquiry ſhall be only ſuch as live in ſociety, ſuch as form with toil and induſtry a ſort of cakes, compoſed of hexagonal cells like thoſe of bees, but made of materials very different from wax.

Theſe heaps of cells are principally deſtined to lodge eggs and embryos till they are able to take flight. We give the name of a waſp-neſt to *theſe* cakes, including under that term all that the waſps build round about the cakes. We ſhall content ourſelves with *diſtinguiſhing* theſe inſects into three claſſes; and *that*, with reſpect to the places they chuſe for building their neſts. Thoſe of the firſt claſs attach themſelves to plants and branches of trees. There are ſeveral ſpecies of this kind, which are all of the ſmalleſt ſize, and compoſe likewiſe no very numerous ſtates. The waſps of the ſecond claſs commonly place their neſt under a covert; they build it either in the hollows of trees, or in granaries that are little frequented. Theſe are the largeſt of all, we call them hornets. Laſtly, thoſe of the third claſs build only under ground; they are not ſo big as the hornets, but are ſometimes bigger than thoſe of the firſt claſs; they are the moſt common of all in the kingdom, and aſſembled in the

greateſt

greateſt number; ſeveral thouſands of *theſe* live together in ſociety.

The waſps of all theſe claſſes reſemble each other in their contrivances; they work all their neſts pretty much with the ſame art; their occupations are nearly the ſame within their neſts; ſo that I ſhall give only the hiſtory of *thoſe* of the third claſs *in detail*, and ſhall barely mention the others as occaſion offers itſelf of taking notice of any thing particular. In order to make them known, it is ſufficient to obſerve that they are *thoſe* of the third claſs, againſt whom we have ſo much difficulty to preſerve our fruits, particularly the muſcadine.

Theſe waſps that build under ground, are not only greedy of fruits, but muſt be ranked amongſt the moſt carnivorous inſects; they make cruel war upon all other flies; what they catch by chaſing is not ſufficient for them; you find them in great numbers in butchers ſhops in the country. After having ſatiated themſelves *there* with meat, they cut off ſometimes pieces bigger than the half of their body, and carry them to the neſt. On each ſide of the mouth they have a talon, or, if you will, a long moveable tooth; the extremities of theſe two teeth or talons are dented like a ſaw; it is with theſe teeth that they cut off pieces of meat, which they gnaw all round and underneath till the ſlice holds no longer by any thing: they are employed

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on it with ſo much eagerneſs, that it would be eaſy to kill them even with the hand, without any riſk of being ſtung, and to deſtroy in that manner a great number of them every day. Notwithſtanding their robberies, the butchers in the country live in tolerable peace with them: I have a butcher at Charenton that does more, he even makes their robbery turn to his account. They are particularly fond of a calf's liver, he therefore allots them one every day towards the end of ſummer, or ſometimes only the milt of an ox; they attach themſelves to this food by choice, and will touch no other meat: whether it is that *theſe* are more to their taſte, or whether, being more tender and leſs fibrous, they are more eaſily cut? It is not however merely to hinder them from touching other meats, that he abandons to them *theſe*; another reaſon, of œconomy, induces him to it. Flies, and particularly the large black flies, depoſite their young upon meats, which cauſes their corruption much faſter. Now the waſps defend the meat from theſe large flies; they dare not remain in the ſhop, there is no ſafety for them, they are purſued by the waſps; and it coſts the butcher no more for the defence of his ſhop, than the milt of an ox, or at the moſt the liver of a calf each day.

When they are ſatiated, and loaded with plunder, they return to their neſt. The firſt

gate

gate that conducts into it, is an hole about an inch in diameter, the opening into which is on the ſurface of the ground; the edges of the hole are turned up like the burrows of a rabbit warren, but the earth round about it is covered with graſs. This hole is a kind of gallery that the waſps have undermined; it ſeldom goes in a ſtraight line, but in windings and turnings; the paſſage is not always of the ſame length, becauſe the neſt is ſometimes nearer, ſometimes further from the ſurface of the earth. I have never found any neſt, whoſe higheſt part was not at leaſt half a foot, but I have found ſeveral, that have been more than a foot, or a foot and half diſtant from the ſurface.

This hole is the paſſage that leads to a little ſubterraneous town, which is not built indeed in our taſte, but yet hath its ſymmetry; the ſtreets and apartments are regularly diſpoſed; it is even ſurrounded by *walls* on all ſides: I do not give this name to the ſides of the hollow where the neſt is ſituated, but the walls I ſpeak of are in reality only paper walls, yet ſtrong enough for the uſes to which they are deſtined; they are ſometimes more than an inch and half thick.

Theſe walls, or, to ſpeak leſs metaphorically, this external covering of the waſp-neſt hath different figures and ſizes, according to the figure and ſize that the waſps have given to the works, which it includes. Commonly the

the external figure of the neſt reſembles a bowl or a ſpheroid, whoſe leaſt diameter is ſometimes horiſontal, and ſometimes vertical. I have found ſome neſts that had the figure of a cone flatted, and ſomewhat narrower towards the baſe. This cone was between 15 and 16 inches high, and was about a foot in diameter near its baſis: the diameter of thoſe which reſemble a bowl, is commonly between 13 and 14 inches.

I have ſaid that the external covering is a ſort of paper; I know no ſubſtance which it reſembles more, tho' it differs a little from our paper; its predominant colour is an aſh-grey, with divers ſhadowings; ſometimes it inclines very much to a white, and ſometimes to a brown or yellowiſh: theſe colours are irregularly varied by bands or ſtreaks about a line broad, which gives a very remarkable colour to the whole outſide of the neſt, and makes a ſort of *marbling*.

But what renders it ſtill more ſingular, is the arrangement of the different pieces, of which this covering is compoſed; we have compared it to bowls and to cones, but we did not deſign to convey an idea that it had the *poliſh* of bowls: on the contrary, its ſurface is extremely rough; at the firſt view you would take it for a rock made of icicles. We ſhall deſcribe it more particularly in ſpeaking of the manner of its ſtructure.

Each

Each neſt hath two round holes, by the one of which the waſps conſtantly enter, and come forth by the other; each hole can let but one waſp paſs at a time; altho' the holes are narrow, by means of this *regulation* the motion of the waſps is never retarded.

We are yet only arrived at the gates, we we will now enter into an examination of the inſide of the neſt. It is occupied by ſeveral flat cakes, parallel to each other, and all placed nearly horiſontal. They reſemble the cakes or honey-combs of bees in *this*, that they are every one an heap of hexagonal cells, very regularly built; but they differ from the honey-comb in many circumſtances; *they* are made of the ſame materials as the external covering of the neſt, that is to ſay, of a ſort of paper; *whereas* the cakes of bees are compoſed of *two* ranges of cells, of which ſome have their openings on one of the faces of the cake, and others open on the other face; *thoſe* of the waſps have only a *ſingle* range of cells, and *all* have their openings at the ſame place, namely at the bottom. *Theſe* cells contain neither wax nor honey, they are deſtined only for lodging eggs, for the worms that are hatched from them, and for the young waſps that have not yet taken flight; *whereas* the worms that are the offſpring of bees lie almoſt horiſontal; *thoſe* of waſps ſtand almoſt direct, with their head downwards, becauſe they have it always turned towards

Vid fig. plate 4.

towards the opening of the cell. The thickneſs of the cakes is pretty near equal to the depth of the cells, and proportionate to the length of the flies.

All waſp-neſts do not contain an equal number of cakes; I have found in ſome to the number of 15, and in others no more than 11; the diameter of the cakes varies in the ſame proportion as *that* of the covering. The firſt, the uppermoſt of the cakes hath often no more than *two inches*, whilſt thoſe of the middle have *a foot*, in diameter; they are likewiſe ſmaller than thoſe of the middle.

All theſe cakes are diſpoſed like ſo many floors, or ſtories, which furniſh lodgment to a prodigious number of inhabitants; we may make a groſs calculation of them. Inſtead of 15 cakes, *un-equal* in diameter, let us ſuppoſe that they are every one 8 *inches* in diameter; or, to make a more commodious calculation, let us ſuppoſe theſe cakes to be ſquares whoſe ſides are 8 inches. I do not believe that I have been too favourable to our calculation. I have found that 7 cells ranged in a row took up no more than the length of an inch and half. By conſequence in an inch and half ſquare there are 49 cells; now if an inch and half ſquare give 49 cells, 49 inches ſquare, which are the ſurface of one of our cakes, will give about 1067 cells; therefore our 15 cakes will have about 16005 cells. Indeed there is ſomething to be bated in this

ſum on account of the inequality of the cells, which we ſhall mention hereafter. But tho' we ſhould allow only room for ten thouſand flies, it would be ſufficient to give an idea of the numerous people of theſe little republics; particularly when it ſhall be ſeen that there is not perhaps a cell that one with another doth not ſerve to produce three young waſps. Thus a waſp-neſt breeds in a year more than 30,000 waſps.

The different *floors* or cakes, leave between them a free paſſage for the waſps; there is always between one and another half an inch diſtance, yet *this* doth not make very lofty ſtories, but their height is proportionate to *that* of the inhabitants. They are all ſuſpended in ſuch manner that the *firſt* bears almoſt the whole weight of the others; it is faſtened to the roof of the waſp-neſt, the *ſecond* is faſtened to the firſt, the *third* to the ſecond, and ſo on ſucceſſively to the laſt. They are *thus* connected together by a ſort of *little columns*, conſiſting of the ſame materials as the cakes and the reſt of the neſt; the architecture of theſe columns is indeed very *plain*, they are barely round, their baſes and chapiters however have a larger diameter than the reſt; by the *one* they are connected to the inferior cake, by the *other* to the ſuperior. They have towards the middle ſcarce more than a line in diameter, but at the baſe and chapiter more than two lines. There is

therefore

therefore between every two cakes a ſort of ruſtic colonnade, for the great cakes are ſuſpended by more than fifty ſuch columns. The cakes are faſtened likewiſe in ſome places to the borders of the waſp-neſt, which conſequently lightens the weight of each ſuperior cake.

Hitherto we have only given a general idea of the edifice; we ſhall now ſhew how the waſps build it, of what uſe it is to them, on what they are employed in the inſide, in a word, we are to pry into the whole government of this little people. But theſe are ſtate-myſteries that paſs under ground, they are not to be penetrated into, if the waſps are left in their natural habitations. I have attempted to draw them from *thence*; I have tried to put them more within reach of obſervation, and have ſucceeded ſo far as to lodge them in glaſs hives, ſuch as the curious make uſe of for bees. *There* I have at leiſure ſeen all their little contrivances, and have ſhewn them to ſuch perſons as have viſited me at my country houſe.

It doth not ſeem eaſy to tranſplant the lodging of ſuch un-tractable inſects; but the love they bear their young hath gained me ſucceſs. If there be any caſe wherein natural hiſtory expoſes a man to hazards, *this* ſurely is one. You muſt brave the ſtings of ſeveral thouſands of waſps, that on all ſides attack you on attempting to diſturb them.

The wounds they inflict are not indeed mortal, but are extremely painful.

With an undaunted ſpirit of philoſophical heroiſm, Mr. De Reaumur encountered theſe difficulties, and diſlodged a neſt together with all the earth that naturally environs it. I ordered a ſervant, ſays he, whom I had diſciplined and armed cap-à-pe for theſe wars, to cut up a large clod of earth, in the middle of which was incamped a neſt. After having conveyed the whole clod into my garden, I pierced it in different places in order to procure peep-holes for ſeeing what paſſed about the neſt; but I found afterwards that it was of no uſe to take away their neſt *upon a clod*; the love theſe inſects have for their neſts or rather for their young is inconceivable; whatever diſorder and confuſion is made in their neſts, altho' it be broken and almoſt torn in pieces, they never abandon it, but follow it every where; it is full of young waſps that require their care and nurſing; inſomuch that in order to have an hive, wherein a waſp-neſt hath been put, well peopled, you need only give theſe flies ſufficient time for returning to their neſt, and for that purpoſe wait only till the evening before you tranſplant it, otherwiſe you loſe thoſe that were out in the country. Thoſe that happen to be abroad when a neſt is tranſplanted, at their return to their hole finding no more their companions nor neſt, know not which way to go, but

continue

continue ſeveral days about the hole before they determine to quit it.

After they have been put in the hive they begin with working to repair the diſorders of their neſts. They remove with wonderful activity all the earth and filth that may have fallen into the hive; afterwards they take care to faſten their neſt firmly to the ſides of the hive where it has been placed; they work at repairing the breaches; are employed in making it ſtronger, and increaſe conſiderably the thickneſs of the external covering.

This cover of the waſp-neſt is a work particular to theſe flies; bees do not cover *their* cakes or combs. We have already mentioned that this cover is more than an inch and half thick: it is not of a maſſy thickneſs, but compoſed of ſeveral vaulted ſtrata that leave vacuities between them. In proportion as the waſps thicken this cover, they build on the ſtrata already formed another ſtratum compoſed of the like vaulted pieces.

The cover is a kind of box, that ſeems made for including the cakes and ſheltering them from the rain which penetrates ſometimes through the ground. It is proper for this purpoſe, altho' it conſiſts only of a ſort of paper, by means of the architecture we have been mentioning: had it been intirely maſſive, it would have been more eaſily ſoaked through. By being *arched* the water that hath penetrated through *one* arch can only

wet *that* underneath by droppings, whereas if the whole was maſſy the water would pervade by contact alone: beſides, this ſort of architecture ſaves a great number of materials. Nothing is more amuſing than to ſee them work at enlarging or thickening this cover. There is no work that they carry on with greater diſpatch; a great number of waſps are employed on it, but the whole is performed without any confuſion. They fetch the materials neceſſary from the country round about; the waſp, that collects them, *herſelf* employs them on the work; the builder or maſon-waſp (for others have other employs which we ſhall mention preſently) returns loaded with a *little ball*, which ſhe holds between thoſe two talons, that we have ſaid ſhe makes uſe of for cutting off pieces of meat. This ball is the *matter* prepared for the work; the waſp being arrived at the neſt carries it to the place ſhe would enlarge; the ball is ſoft as paſte; ſhe faſtens herſelf to the part on which ſhe hath applied and preſſed her little ball. Immediately afterwards you ſee the waſp retiring backward, and as ſhe moves ſhe leaves a *portion* of her ball, but not detached from the reſt, which ſhe holds between her two fore legs. Imagine to yourſelf a paſte that is ropy, or a piece of ſoft clay, that you would add round the brim of an earthen veſſel, and you will form an idea of the manner in which the waſp labours. Her two

talons

talons act as the thumb and finger of the potter would do, in pasting new earth to the brims of the vessel, in drawing it out, and flattening it down.

This new *rim (perhaps the Latin word fascia will more fully convey the meaning of the French term bande)* that hath been applied is *yet* too gross and unpolished; her next work is to make it thin and smooth; she goes without the least loss of time, and resumes her task *where* she first begun. This second labour is pretty much the same *in the manner of working* as the former. Her talons by patting the soft matter extend it; she goes over the work in this manner 4 or 5 times till she hath reduced the additional part to the thinness of the rest, or to *that* of a leaf of paper. It must be observed that it is with extreme quickness that the wasp labours, and always retiring backward; by this means she is in a condition of judging continually whether her work is good: the motion of her talons is much quicker than *that* of her legs. Each *rim or leaf* is about a line in breadth, and are *all* of different colours; which is owing to the different coloured materials, of which they have been composed. This I was convinced of by the following expedient: With a stick smeared at the end with glue I took out of the hive whatever wasp I had a mind for; those that I took, loaded with *a ball*, never quitted it notwithstanding the vio-

lence that I did them; they would ſtill preſerve the fruit of their labour. Amongſt theſe *balls* ſome were white, others yellowiſh, and others blackiſh.

We are now to examine the compoſition of theſe *balls*. There is nothing in the whole hiſtory of theſe inſects that was longer concealed from me. In vain had I obſerved waſps on all occaſions when I could ſuſpect that they were going to collect materials, I could never ſucceed in ſurpriſing them at the time they were loading themſelves. Bees that gather their wax and honey on flowers, even waſps themſelves, that ſettle on plants and trees in order to ſuck the juice of the leaves or what exſudes from the ſtems, had thrown me wide of the mark; I thought to find them on ſuch plants tearing up fibres for forming their paper. After a fruitleſs ſearch and *when* I no longer purſued my enquiries on this inſect, a mother waſp, of the ſubterraneous kind, came to inform me of what I had ſought ſo often in vain. She placed herſelf near me on the frame of my window that was open. I ſaw her continue at reſt in a place, from *whence* I could not imagine ſhe could draw any thing very ſucculent. Whilſt the reſt of her body was *ſtill*, I remarked divers motions of her head. It immediately came into my thoughts that the waſp detached from the *frame* materials for building, and the notion proved true. I obſerved her with attention;

attention; ſhe ſeemed to nibble the wood, her two talons acted with extreme agility in cutting off fine pieces. She did not ſwallow what ſhe detached, but added it to a little heap of the ſame materials which ſhe had already collected between her legs. In a little time ſhe changed her place, but ſtill continued nibbling. I afterwards catched the waſp whilſt ſhe was buſy on this work; I found her loaded with pretty near ſuch a quantity of materials as they are wont to carry to their neſt; ſhe had not however *yet* formed it into a ball. The matter was not moiſtened ſo much as it is when the inſect cements it to her work.

I examined this heap of filaments, which in all reſpects, except *that* of not being yet well moiſtened, reſembled the balls which I had taken from waſps employed on building. Theſe filaments appeared however very different from what one would expect the inſect to detach from wood by nibbling. One would imagine that they ſhould reſemble ſaw-duſt, that each bit ſhould be pretty near as wide as long; each filament on the contrary was extremely ſmall, altho' it had *at leaſt* a line in length; there were even *ſome* much longer. Big and ſhort pieces of wood, like *thoſe* of ſaw-duſt, would not ſuit our ſubterraneous waſps; *they* could not well be interwove for making a fine paper, it is neceſſary to have a ſort of threads like to *thoſe* of the paper

per which we make uſe of: and in getting *ſuch* we muſt take notice of the great ſagacity of the waſp. She doth not merely haſh the wood, which would only give her little ſhort pieces like *thoſe* of ſaw-duſt; but before ſhe cuts it ſhe makes, as I may ſay, a ſort of ſcraped lint; ſhe preſſes the fibres between her talons, raiſes them up, and by that means ſeparates them one from another; having done *this* ſhe afterwards cuts them.

I learnt this cunning of the waſp, not only from obſervation, but was aſſured of it likewiſe by detaching myſelf the fibres of wood with a penknife. I rubbed *at firſt* the wood lightly with the blade of the penknife in order to ſeparate the fibres one from another, and I rubbed it *afterwards* more ſtrongly in order to detach them. I collected in this manner filaments, which I compared with *thoſe* that the waſp had collected, and could obſerve no difference between them.

Ever ſince I obſerved the waſp detaching wood from my window, I have been attentive to obſerve the actions of *thoſe* that ſettled upon dry wood, and have remarked that waſps of all ſorts go *thither* to cut filaments neceſſary for making their paper. I have ſeen them particularly attach themſelves to the ſupporters of eſpaliers, to the frames and ſhutters of windows. But it is to be obſerved that they attach themſelves only to old and dry wood, which hath been a long time expoſed to the injuries

injuries of the air. It would not be eaſy to *draw* the fibres of *flax* freſh pulled; in order to draw them it is left to *ſteep* for a certain time; that is to ſay, it is kept ſoaking in water for ſeveral weeks, and afterwards is dried. The firſt ſurface of the wood, that hath been expoſed ſeveral years to the injuries of the air, has been ſo often watered by rain, that it is in the condition of flax that hath been ſteeped. The cakes, and columns, that ſupport them, are made of the ſame materials. The waſps likewiſe work the *cells*, that compoſe the cakes, in the ſame manner as the *ſtrata* that form the cover; but the texture of the cells is more *looſe* and reſembling net-work; on the contrary, the texture of the columns is more *cloſe* and compact. Theſe columns are intirely maſſive, it is neceſſary that they ſhould be much ſtronger than the reſt. The waſps *do* them *over* ſometimes with a ſort of varniſh, they rub them with their mouth, the places rubbed appear ſhining and always continue *ſo*. This varniſh is perhaps the glue that binds together the threads of which their paper is compoſed.

N. B. *I cannot help obſerving that the artifice of the waſp in making paper gives great light into the manner, in which the ancients made their paper of the Egyptian papyrus. They might indeed have made it in much greater perfection, had they more carefully*

carefully obſerved and been inſtructed by the waſp; for Pliny in deſcribing the method of making it ſays, præparantur ex eò (ſcilicet papyro) chartæ diviſo acu in prætenues ſed *quàm latiſſimas* philuras. *Mr. De Reaumur hath remarked the great ſagacity of the waſp in avoiding that error, and the reaſon on which her practice is founded.*

The cells of the cakes are hexagonal: but I know not whether this figure enters into the deſign of their architecture, or is owing to the young waſps preſſing the cells and making them take this figure. This is certain, that the outward cells have the half of their circumference *round*.

A great part of the waſps which we ranked in the firſt claſs, of thoſe that build their neſt on plants or on branches of trees, give their neſt no covering at all. Their cakes are *bare* and their poſition is vertical. The ſpecies of this claſs are often content with making a *ſingle* cake; *ſome* give it no more than two or three inches diameter, *others* give it five or ſix inches. Sometimes however they make two or three cakes parallel one to another.

There are in the kingdom waſps of *this* claſs that give their neſts very ſingular covers. Mr. Varignon brought one of them to the academy ſome years ago, whoſe covering reſembled very much a roſe not yet *blown*; It

Vid. plate 5. fig. 2.

was

was in *like manner* compoſed of ſeveral leaves applied one upon another.

But all the waſps of this kingdom, that I know of, form nothing ſo ſingular as a ſpecies of waſp at Canada, whoſe neſt is in the cabinet of the king's garden, and hath been communicated to me by Mr. Vaillant. At the firſt view, and even after having examined *ſome time* the ſurface, one would take it for a work of human compoſition. Its cover reſembles ſo much our paſte-boards, that it is not enough to ſay it reſembles them; you can find no difference between the one and the other: it hath the poliſh, the colour (which at preſent is *that* of old paſte-board but was formerly white) and likewiſe the texture. It is a fine paſte-board and as thick as *that* of common portefolios. This cover approaches in figure to a cone, but the ſummit of the cone is not very pointed; near the ſummit it hath a long hole through which paſſes a branch of a tree, that had been choſen by the inſects for ſuſpending their neſt, one could not draw out this branch without tearing the paſte-board. Vid plate 5. fig. 1.

The waſps of the ſecond claſs, the biggeſt of all and called hornets, make in granaries and in hollows of trees their neſts pretty much like *thoſe* of our ſubterraneous waſps, only their paper is of a coarſer ſort, the predominant colour of it is yellowiſh, whereas *that* of the ſubterraneous waſps is an aſh-grey.

The

The waſps of all theſe claſſes begin with building the firſt or ſuperior cake. Before they begin on a cake, of whatever range it be, they form one of the columns that is to ſuſpend it; upon the inferior *end* of this column they build the firſt cell of the cake; they ſurround it afterwards with other cells; they begin to form new columns in proportion as the increaſe of the number of cells requires it, and they extend the outward cover in proportion as the number of cakes inlarges.

The conſtruction of the waſp-neſt is not the only employment of the waſps, it is but a ſmall part of them which are concerned in the building; the others have other employs. In order to ſhew their different occupations it is neceſſary to give a more perfect knowledge of the inhabitants of our little commonwealth, than we have hitherto given. What we are going to relate of them will ſerve to confirm the notions of Mr. Maraldi with regard to bees.

In the inſect kind *thoſe* which have ſtings are a people quite *diſtinct*, that have ſcarce any ſimilitude with any others. The ſame waſp-neſt is inhabited by three ſorts of waſps different in ſize, and which have ſome differences likewiſe in ſhape; or they may be diſtinguiſhed into three ſexes, *males*, *females*, and ſuch as I ſhall call *mules*, altho' they have nothing in common with real mules but their

inability of perpetuating their ſpecies: of which I am fully convinced by my own obſervations. The males are amongſt waſps what the *drones* are amongſt bees; the females in the waſp *ſtate* hold the place of the king or queen amongſt the bees. But inſtead of there being only three or four females, as in the bee-hive, I have ſeen in waſp-neſts more than between two and three hundred at a time. Laſtly, thoſe of our waſps, which I call mules, are amongſt *them*, what the *generality* of bees are in the bee-hive.

Theſe mules are the moſt numerous part of this republic; they bear all the burdens of it; it is they that build, that provide food for the males, females, and even the young waſps for a great part of the year. Excepting thoſe which are employed in collecting materials for the conſtruction of the edifice, and in performing the office of maſons, the reſt go in purſuit of plunder; ſome catch inſects, the paunch, and ſometimes the whole inſect is brought home to the neſt; others pillage butchers ſhops; others ravage fruits and carry home the juices they have collected. When they are arrived at the neſt they communicate their prey to the females, to the males, and even to other mules, who on account of their having been employed within doors could not go and provide *themſelves* food. Several waſps aſſemble round the mule that is juſt arrived, and each takes his *portion* of what

what is brought. This is tranſacted with the utmoſt harmony; the following obſervation is a proof of it. Thoſe, which inſtead of going upon the chace have light upon fruits, bring back nothing *ſolid* to the neſt, for they never carry fruits or portions of fruits. Yet theſe mules, which in appearance bring back nothing, contribute to the regaling their companions. I have ſeen them ſeveral times, after they have entered the hive, repoſe themſelves quietly on the upper part of the neſt; after *which* they diſcharged from their mouth a drop of clear liquor, that was greedily ſucked up, ſometimes by two waſps at the ſame inſtant; after that drop, the mule diſcharged a ſecond and ſometimes a third, which were diſtributed in like manner to other waſps.

The mules, altho' the moſt laborious, are the *leaſt* in ſize; they are the moſt lively, light, and active. The females are the *biggeſt* and *heavieſt*, they move more ſlow and ſedate. The bigneſs of the males is of a middle ſize between *that* of the mules and females.

During the months of June, July, Auguſt, and the beginning of September, the mother waſps keep themſelves confined to the neſt, they ſeldom go abroad but in the beginning of the ſpring, and in the month of September; at the other times they are employed in laying eggs and feeding their young, which

is

is no ſmall occupation; indeed *by themſelves alone* they could never ſufficiently attend ſuch a prodigious number of young as we have *before* calculated each waſp-neſt contains. They feed them as birds feed their young ones. Every moment they are carrying them a bill full. It is ſurpriſing to ſee the activity with which a mother waſp runs through the cells of a cake one after another; ſhe puts her head pretty far into thoſe cells where the young are very little, what paſſes *there* is concealed from the eye of the obſerver; but it is eaſy to *conjecture* by what one ſees done in thoſe cells where the young are bigger and ready to undergo their metamorphoſis. Thoſe we have laſt mentioned being more advanced are leſs quiet, they put forth their head quite out of the cell, and by little gapings ſeem to crave for food. The waſps of the larger ſort, the hornets, before they give food to their young, preſs a little their head between the two talons we have ſo often mentioned. I am inclined to think that the attention of the waſps goes ſo far as to adapt the food to the ſtrength of the young, for I have ſeen *ſome* give but a drop of *liquor* to ſuch as were pretty big, and have ſeen *ſolid* food given to ſuch as were bigger. The mothers not being ſufficient to diſtribute nouriſhment to ſo many young, the mules are often employed in that ſervice. I have made an obſervation on the waſps of the firſt claſs, which ſeems to prove

that *they* feed their young in the manner of birds which *diſgorge*, that is to ſay, ſwallow the grain and let it ſoften a little and be concocted in their crop, before they offer it to their young; for I have ſeen a mother waſp of this ſort, which brought home the paunch of an inſect, after having ſwallowed it intirely, go through her cells and leave the young ſome pieces *ſo large* that they were ſcarce able to ſwallow them.

I have taken away fragments of cakes, full of little waſps, which for want of the mother's bill ſucked what I gave them. It would not perhaps have been impoſſible to have *reared* them, if one would have taken the trouble.

N. B. *This experiment hath been ſince tried with ſucceſs by a youth, who took pleaſure in feeding waſps with honey, as the generality of boys delight in breeding birds.*

Vid. Mr. De Reaumur's hiſtory of inſects vol. 6. pag. 190.

The young waſps are not in the cells under the *form* of waſps; when they have taken *that* they remain there but a little time. They are produced from a white, tranſparent egg, of an oblong figure, very like the kernel of a pine apple, excepting that it is bigger at one *end* than at the other. Eight days after the egg hath been laid you find in the cell

cell a worm, which is conſiderably bigger than the egg; perhaps this worm is the egg itſelf more developed; the head is *then* diſcernible, you may diſtinguiſh the two talons. The worms continue to grow till they become big enough to fill intirely their cells. When they are arrived at that ſize, they are ready to undergo their metamorphoſis; they have no longer need of taking food, they enjoin themſelves a faſt, and forbid all commerce with other waſps. They ſtop up the mouth or entrance of their cell, by making it a little cover; ſome worms make it almoſt *flat*, *theſe* are commonly ſuch as are to be mules, others make it *convex*, and even extend *a little* the ſides of the cell by making a border of the ſame materials as the cover. The cover is of a texture like *that* of the cod of caterpillers or ſilk-worms. Our *worms* of waſps ſpin and weave this cover preciſely as caterpillers ſpin their cod; they give themſelves the ſame motions of the head. The thread, of which they form it, is ſo fine that I could never obſerve exactly from whence they draw it, altho' I have ſometimes held in my hand the cakes where the worms were at work in incloſing themſelves. It appeared, however, to me that the thread came like *that* of caterpillers from a little below the mouth. In about 3 or 4 hours the cover of a cell is intirely finiſhed; I have often taken pleaſure in breaking *thoſe* that were begun,

in order to make them renew their work; but it is neceſſary that there be remaining ſtill a *proviſion* of ſilk in the worm; for if you deſtroy a cover that hath been made ſeveral days, the worm will weave no more. Theſe covers are extremely white, particularly in the neſts of hornets.

I have not made very exact obſervations on the number of days between *the laying* the egg and the worms *incloſing* itſelf in the cell. I think however that the number of days in the waſps of the firſt claſs doth not exceed one and twenty. This I am certain of, that the worms of the waſps of that claſs do not continue above nine days in their cells, after they have ſtopped them up. A little after the worm hath incloſed himſelf, he is tranſformed into an *aurelia*; he quits his ancient *caſe* or ſkin, and is cloathed with *one* extremely thin, and ſo tranſparent that it lets the ſhape and colour of all the parts of the waſp be ſeen, altho' the inſect is as it were ſwaddled in it. At laſt, about the 8th or 9th day the inſect ſtrips off this laſt covering, and appears under the form of a fly. The firſt *caſe* or ſkin remains ſo exactly applied to the ſides of the cell that it ſeems to make a part of it. The waſp, that hath juſt diſengaged himſelf, begins with making uſe of his talons or teeth, as we have deſcribed them before; which he employs in nibbling *all round* the cover that incloſed him; the cover being thus

thus detached, he quits his *abode* with eaſe. The hornets or large waſps begin with nibbling their cover in *the middle*, and inlarge the hole continually till it can let them paſs through.

The waſp that is juſt at liberty from its cell is not different from thoſe of its ſpecies and ſex but in this, that it is of a more pale yellow or citron colour; he ſoon takes the benefit of the food, that hath been brought to the neſt by others. In waſp-neſts, that are without an external cover, I have ſeen waſps which the very ſame day that they were transformed went into the country, and brought back plunder, which they diſtributed to young waſps in cells. The cell from whence the young waſp is departed doth not continue *long* vacant; as ſoon as it hath been quitted an old waſp is employed in cleanſing it: in a few days you find *there* a new egg; thus the ſame cell ſerves for breeding ſeveral waſps.

As the mules are ſix times ſmaller than the females, their cells are pretty near in the ſame proportion. When we ſaid therefore that in a ſquare, whoſe ſides are of an inch and half, there are 49 cells, we meant only the cells of mules: the ſame ſquare contains much fewer cells of female worms; *theſe* laſt mentioned are likewiſe *deeper*, becauſe the females exceed the mules in length as well as bigneſs.

There are not only cells built ſolely for breeding *mule worms*, and others for raiſing up *females* or *males*; but it is to be remarked that the cells of mules are never intermixed with *thoſe* of males or females. A cake is intirely compoſed of cells for mules, but the cells of females and males are mixed in the ſame cake; they have need of cells equally deep. The males indeed do not want ſuch wide cells as the females, and therefore *theirs* are much narrower, in the proportion that the difference of ſize requires.

Theſe piles of cakes, the maſſy columns that ſupport them, in a word, the whole edifice we have been deſcribing is a work deſtined for a few months only. Thoſe habitations ſo peopled in the ſummer are almoſt deſarts during winter, and intirely abandoned in the ſpring; not a ſingle waſp remains within them. *Thoſe* that have out-lived the ſevere ſeaſon go and begin a new edifice, which together with its future inhabitants owes its origin to a *ſmall* number of waſps, and ſometimes even to a *ſingle* waſp.

One of the moſt ſingular remarks, that the hiſtory of theſe inſects ſupplies, is that the cakes firſt formed are compoſed of cells that can contain none but mules. The republic, whoſe foundations are juſt laid, hath need of *labourers*, and *thoſe* are born the *firſt*. No ſooner is a cell finiſhed, and oftentimes it is not above half built, but an egg of a mule

worm

worm is depoſited in it. As they are firſt born, ſo likewiſe they die the firſt; whatever pains I have taken to cover well my hives, I never could ſucceed in having a ſingle one alive at the end of a mild winter.

The females being much ſtronger and deſtined to perpetuate the ſpecies, ſupport the winter better; but even of *theſe* there ſcarce remained a dozen living, ſome hundreds were periſhed in the hive.

I am not certain that the male waſps periſh *all* in the winter as well as the mules, yet I never could preſerve any of *them* alive in my hives; but I think I have ſeen *ſome* flying about in the beginning of the ſpring.

A female waſp becomes the foundreſs of a republic, of which ſhe is in the ſtrict ſenſe of the expreſſion *the nurſing mother*. The eſtabliſhments they form are very far from being ſo uſeful to us as *thoſe* of bees; they are indeed only noiſome to us: yet we cannot help acknowledging that they have ſomething in them more great and glorious: If the delight of glory be felt by inſects, if ſolid glory amongſt *them* be meaſured as amongſt *us* by ſurmounting difficulties, by accompliſhing enterpriſes uſeful to their kind, each mother waſp is an heroine to whom the mother bee, ſo reſpected by her ſubjects, is not to be compared. *In ſhort, we may juſtly apply to her theſe lines in Virgil celebrating Rome*;

Felix prole virûm: Qualis Berecynthia mater,
Læta deûm partu, centum complexa nepotes.

When the female *bee* iſſues from the hive where ſhe was born, to become a ſovereign elſewhere, ſhe is attended by a ſwarm of workmen that are very induſtrious, very laborious, and ready to execute all the works neceſſary to the new-eſtabliſhment; whereas the mother *waſp* that hath not a ſingle workman at her diſpoſal, ſince we have obſerved that the winter cauſes all the mules to periſh, the mother waſp, I ſay, undertakes *alone* to lay the foundations of her new republic.

The males, which I have already ſaid that I imagine do not *all* periſh like the mules, altho' not ſo idle as the drones or males of bees, yet ſeem not *by nature* fitted for relieving the female waſp in her moſt important labour, *that* of building. They are a kind of cotqueans never employed but in a ſort of houſewifry, ſuch as keeping the neſt clean, ſweeping away the dirt, and carrying out dead bodies.

When the mother waſp begins in the ſpring to build under ground a neſt, which hereafter will be peopled by ſo many thouſand flies her future iſſue, ſhe hath no longer need of conſorting with the males; ſhe was impregnated in the months of September or October,

October, and at that time the numbers of males and females are pretty near equal, ſome hundreds of the one and the other in the ſame neſt.

The courtſhip and the nuptial rites between the ſexes are myſteries that have been revealed to me by means of my glaſs hives. About the middle of October I ſaw the females and the males come upon the outſide covering of the neſt, and keep *there* whilſt it was heated by the rays of the ſun. I could perceive their coupling performed pretty much in the ſame manner as *that* of other flies. I ſometimes ſaw a male waſp in love, moving, as I may ſay, with a diſcontented air, now going forwards, then ſuddenly turning back; as ſoon as he ſaw a female, he ran, he fled with all the wings of love — *The reſt I muſt throw a veil over, and refer the curious reader to Mr. De Reaumur himſelf in his hiſtory of inſects*, vol. 6. pag. 200.

It is ſurpriſing indeed that a ſingle inſect ſhould contain ſo many thouſand embryos, but it is not the only inſtance that nature gives us of it; this fruitfulneſs is perhaps much inferior to *that* of many ſorts of fiſh.

The females and the mules have a *ſting*, the males *alone* are unprovided with it. The ſting of the females reſembles *that* of the mules, but is much longer and bigger. The violent ſmart it occaſions is produced by a venomous

nomous liquor, that is very limpid, introduced into the wound.

Peace doth not always reign in the republics of waſps; there are often combats between mule and mule, and between mule and male. The *laſt*, altho' bigger, are more weak or greater cowards; after having held out a little while, they betake themſelves to flight: in general the combats ſeldom end in death, tho' I have ſometimes ſeen the male killed by the mule. Our female waſps are leſs murderers than the bees; they do not treat ſo ill their males as the bees treat their drones.

But now the ſcene changes; about the beginning of October the waſps ceaſe to think of nouriſhing their young; from *being* tender mothers and nurſes they become unmerciful ſtep-mothers; they tear out of the cells the worms that have not yet incloſed themſelves, they carry them out of the neſt; mules and males are employed in the cruel work, but I never ſaw a female engaged in theſe barbarous expeditions. It is not one ſingle ſpecies of worms that the waſps attack, (as Mr. Maraldi hath obſerved of bees, who at a certain ſeaſon deſtroy the worms of drones) mules drag their fellow mules, and males tear to pieces males; the maſſacre is general. Shall we endeavour to conjecture the reaſon of ſuch apparent barbarity? Is it that they chuſe rather to put to death their young that they

they imagine they ſhall not be able to rear, or that they judge will never come to any thing on account of the cold weather they are threatened with? for the cold pinches them all extremely. As ſoon as the hoar-froſts begin they never ſtir abroad, till the ſun hath warmed the air; as the cold increaſes, they have not ſtrength to purſue the flies, that are their prey; at length the cold deſtroys them. A few females only ſurvive; *theſe* paſs the winter without eating, for they do not make *ſtores* like the bees, indeed if they had *any* they would not make uſe of them: I have often put into their neſt ſugar, honey, and other foods which they were fond of in the ſummer, but in the winter they did not touch them.

In every ſeaſon on days of continued rains and high winds they never ſtir abroad; all keep faſt, for they have nothing *provided*.

The ſubterraneous places inhabited by our waſps prove that they are naturally great miners, that they make holes and turn up earth with great dexterity. Perhaps they may take advantage of holes that have been made by *moles*, but *ſtill* there muſt be a great deal of earth to remove in order to make thoſe holes 14 or 15 inches diameter, which the ſize of their neſt very often requires. If you ſtop up the mouth of one of theſe holes with earth, as I have often done, they do not long continue priſoners; in a few hours they get thro' this

this new earth, and remove it away; for the performance of this work they make uſe of their two talons or teeth.

The ſting of the waſp is an hollow tube, open near its point, at which opening iſſues the venomous liquor. Having been ſtung by a waſp I bore it with patience, and let her draw back her ſting at leiſure; I then catched her and put her on the hand of a ſervant, whom I had diſciplined *ſo* as not to regard *being ſtung*: after having provoked the waſp ſhe ſtung him, but the ſmart was very little; I immediately took the waſp and made her ſting me a ſecond time; I ſcarce felt it, the venomous liquor had been almoſt exhauſted; I then provoked the waſp, but in vain, for ſhe would not inflict another wound.

This experiment and ſome others, that perhaps no one will have an inclination to repeat, have diſcovered to me that if you let yourſelf be ſtung peaceably, the *ſting* never ſtays behind in the wound; it is flexible, doth not pierce an hole direct, but makes the wound in zic-zac: if you oblige the waſp to draw it back ſuddenly, the friction is great enough to retain the *ſting*, which is as it were a little hooked in, ſo that ſhe tears it away; whereas if you do not hurry the waſp, ſhe gently diſengages it by little and little.

Memoirs 1719, *pag.* 230.

But

But as Mr. De Reaumur hath made ſome corrections of his memoir, preſented to the academy, in his edition of the hiſtory of inſects, vol. 6th, I have in ſome particulars extracted from thence.

Of moths by Mr. de Reaumur.

This kind of inſect ſo deſtructive to our woollen manufactures and to our furrs, is but too well known by the ravages they commit; yet the miſchief they do us hath not hindered the moſt eminent writers in natural hiſtory from ſpeaking of them with encomiums. Their induſtry ſtrikes us with admiration as ſoon as we apply ourſelves to the ſtudy of them.

Enquiries of natural hiſtory, had they only for their object to diſplay the prodigious variety of *beings* in the univerſe, though they ſhould only aſſiſt us to form more enlarged ideas of the author of ſo many marvellous works, deſerve not to be treated as frivolous; for *ſo* they ſometimes are, by people who do not in reality propoſe to themſelves more ſolid objects: but in fact ſuch enquiries, as are merely curious in appearance, may tend as directly, as *thoſe* of any other kind, to what we call real utility, to what hath relation to our wants and conveniencies. A thouſand examples concur to eſtabliſh this truth, that obſervations in natural hiſtory have contributed as much to the progreſs of arts, as the moſt beautiful inventions in mechanics.

Whoever

Whoever by ſtudying the nature of moths, by obſerving them carefully throughout their whole exiſtence and under all their forms, ſhould arrive at the diſcovery of ſome ſecret for deſtroying them, or for defending from their teeth ſuch of our manufactures as are their uſual prey, would not *he* have diſcovered ſomething as uſeful, as *one* that ſhould find out a new method of manufacturing wool, which would conſiderably increaſe the duration of the ſtuffs made from it? This conſideration alone was more than ſufficient to determine me to follow with attention a ſpecies of inſects, that in other reſpects invites obſervers by abundance of ſingularities, and yet hath never been hitherto conſidered with accuracy.

Hairs, feathers, ſcales, and ſhells, cover the external ſurface of the body of different ſorts of brute animals; nature hath given *them* very ſolid coverings, to defend them from the injuries of the air, and from the frictions of bodies which would otherwiſe gall them; *we* ſupply by art and induſtry what hath been refuſed us by nature. She hath likewiſe refuſed veſture to the moths, but hath taught them to clothe themſelves with ſtuffs very like to *thoſe* which we employ to the ſame uſes. Their head, their talons, and ſix paws, which are ſituated near the head, are all that they have *ſcaly*; the reſt of their body is covered with a white, thin,

thin, and tranſparent ſkin, and conſequently muſt be extremely tender and delicate: you barely ſee a few hairs diſperſed up and down through their whole body. They may truly be ſaid to come into the world *naked*, and to make themſelves real cloaths; ſome make them of wool, and others of hairs; I ſay *real cloaths*, becauſe the coverings of moths ought not to be confounded with the cods that ſilk-worms and divers caterpillers form; theſe *laſt* are *cloſed* on all ſides, the animal includes himſelf *there* in order to undergo his metamorphoſis; he is to continue *there* a conſiderable time without moving or taking nouriſhment; whereas the moths never quit their kind of habit, but wear it wherever they go. It is this contrivance of the moths to clothe themſelves that naturaliſts have admired, and indeed have been content with *admiring*, for they have not taught us by what artifice the inſect manufactures, if I may be allowed that expreſſion, the ſtuff with which he covers himſelf, nor what is its texture.

The moth is not of a ſhape very difficult to be adjuſted; the body of the inſect is of a form approaching to a cylinder; in order to cover it there is wanting only a ſort of tube, and *ſuch* is its cover: it is an hollow tube that runs the whole length of the animal, open at the two ends; near which it hath commonly a little leſs diameter than towards the middle; in the oldeſt moths it is between

between four and five lines in length, and very rarely ſix. All the external part of this tube, or, as we ſhall moſt commonly call it, *ſheath*, is a ſort of woolly texture, ſometimes green, ſometimes red, and ſometimes grey, according to the colour of the ſtuff from whence the moth had pilfered. Sometimes divers colours are found mixed in very ſingular varieties; moſt commonly theſe different colours are diſpoſed in the manner of *ſtripes*. It muſt be obſerved, that it is only the *external* part of the ſheath which is of wool; all the *inſide* is a white-grey ſilk, ſpun by herſelf. You may conſider it as a *lining* to the reſt of the ſtuff, or rather the ſheath is made of a ſort of ſtuff, in which the greateſt part of its thickneſs is of wool, and the reſt is of ſilk; a kind of tiſſue that we have not yet thought of imitating.

The ſtate of the moth, like that of the caterpiller, is tranſitory; they are in the ſame manner to be metamorphoſed into butterflies, and it is under this laſt *form* that the females depoſit eggs to perpetuate their ſpecies. From the middle of ſpring to the middle of autumn you ſee, flying upon hangings and beds, little butterflies of a greyiſh-white, againſt whom the good houſewives proclaim juſt war. Theſe are the butterflies into which the moths have been transformed. In order to trace our inſects from their birth, I have taken ſeveral butterflies of this kind,

I ſhut up ſome that were very lively in cylindrical glaſs bottles, (called in French *poudriers)* the mouth of which is pretty near as wide as the bottom: into theſe glaſs bottles I had put ſome pieces of *ſtuff*, ſome of theſe butterflies laid their eggs *there*. The eggs are very ſmall, it is as much as good eyes, without the aſſiſtance of a glaſs, can do to ſee them; you may diſcern their figure to be like *that* of common eggs, they are white, and have a ſort of tranſparency. I was not able to remark the worms at the time they were hatched, nor to know preciſely how many are hatched; all that I know is that about three weeks or a month after the butterflies had depoſited their eggs, I found little moths, and no longer found the eggs whoſe *places* I had remarked.

In a very little time after they are born they begin to make their cloathing. You find them wrapt about with their covering, when they are yet ſo ſmall that you cannot be aſſured of their being *covered*, without the aſſiſtance of a glaſs. What nature teaches is learn'd early.

But to purſue the artifice of their labour, we muſt take them in a more advanced age. For example; let us confine ourſelves to a moth of a ſenſible bigneſs, ſuch as *one* of two or three lines. As her body grows, the ſheath will ſoon be too ſhort to cover her, ſo that the inſect is every day employed in

lengthening her garment, which entirely covers her when ſhe is not in action. We have already ſaid that it is open at both ends: when the animal would work in making her garment *longer*, ſhe puts forth her head at that end to which it is neareſt; you ſee her extremely active in ſearching after proper nap of wool; her head changes from place to place continually. If the nap that is near is not ſuch as ſhe would have, ſhe draws ſometimes more than half her body out of the ſheath, in order to ſeek for better at a greater diſtance: when ſhe hath found ſuch as ſuits her, her head is fixed for a moment, ſhe ſeizes it with two talons, that ſhe hath underneath her head and near her mouth, and tears it up after repeated efforts; immediately ſhe conveys it to the edge of her tube or ſheath, to which ſhe faſtens it. She repeats the like work ſeveral times ſucceſſively.

I ſaid that the moth *tears up* this bit of wool from the ſtuff, and in reality you ſee her pull as if her deſign was to tear it; but I know not whether ſhe doth not cut it, the ſhape and ſituation of her two talons, together with the uſe ſhe makes of them in other circumſtances, concur to give me this notion.

If the moth repeated continually the work we have been mentioning at the *ſame* end of the ſheath, ſhe would only lengthen it at *that* end, ſhe would not give it the ſhape of a ſpindle, as it commonly hath. It is there-

fore

fore neceſſary for her to lengthen it ſucceſſively at each end; and in fact ſhe doth *ſo*. After having worked for a minute, and ſometimes only a few ſeconds, at one of the ends, ſhe thinks of making it longer at the other; one is ſurpriſed to ſee the head come out at the *latter*, which before came out at the *former*; one is almoſt inclined to think that the inſect hath two heads, or at leaſt that the end of the tail is made like the head, and hath the ſame cunning in chuſing and gathering the bits of wool. The truth is however that it is the head which appears ſucceſſively at the two ends of the ſheath. In order to explain *this*, it muſt be obſerved that the ſheath is much wider than is neceſſary to contain the body of the inſect, it hath almoſt double the diameter of the animal. When the head hath worked ſufficiently at one of the ends, ſhe bends herſelf round, and advances her head towards the place where her tail was; ſhe continues advancing it till ſhe is bent almoſt double; *then* ſhe draws back her tail towards the place that was before occupied by the head: thus the inſect turns herſelf in her ſheath from the one end to the other. She performs this *turning* ſo quickly, that one would not think ſhe could have time to do it.

I was willing to ſee her perform this motion in ſuch manner as to leave no room for doubt. By preſſing gently one of the ends

of the ſheath, I obliged the moth to advance a little towards the other end; I *then* cut off with my ſciſſers the part which I had forced her to abandon; the ſame contrivance repeated ſucceſſively at each end, reduced the ſheath to a third of its former length. The inſect being by this means more than half *bare*, and under a neceſſity of cloathing herſelf anew, laboured at it very hard: I *then* could ſee in what manner ſhe bends herſelf double in turning her head from end to end. Under this circumſtance the main part of the fold of her body was out of the ſheath, but commonly it is in the middle of it; and it is on this account that the middle is more ſwelled out than the reſt. In this caſe likewiſe it was very eaſy to obſerve her work; ſhe performed more in 24 hours, than ſhe would otherwiſe have done in ſeveral months, neceſſity urging her to a new cloathing.

When the moth, in labouring to lengthen her ſheath, doth not find a nap of cloth to her *liking* as far as her head can reach, ſhe changes place from time to time; ſhe moves with a good deal of ſpeed, always carrying her ſheath with her; *then* her head and her ſix paws are out of the ſheath, for it is by means of thoſe feet that ſhe moves. She hath two other paws, that are ſhorter, ſituated near her tail; the uſe of theſe is to faſten herſelf to the ſheath; they take hold of it, and make it advance with the body of the animal,

animal, whilſt the other feet advance her forwards; ſhe ſtops *where* ſhe finds a ſuitable nap, and works at extending her ſheath.

We have yet only deſcribed the half of her work: at the ſame time that the inſect becomes longer, ſhe grows likewiſe bigger: very ſoon her garment would be too ſtrait about her, and not let her perform all her neceſſary works. I diſcovered by very accurate obſervations, that the moth doth not caſt off her habit when it becomes too narrow, like the crawfiſh, but actually enlarges it; and tho' the manner of her enlarging it is very ſimple, I did not at firſt conceive it.

I put ſome moths, whoſe coverings were of a ſingle colour, upon ſtuffs of a ſingle but different colour; moths with blue ſheaths upon red cloth, *thoſe* with red ſheaths upon green or grey, *&c.* After ſome time I ſaw the tubes made longer and wider; as circular folds, made of the nap of the new ſtuff I had given them to nibble, ſhewed the lengthening of each end, ſo two ſtripes that went in a ſtraight line from one end to the other, ſhewed the widening that had been made. Theſe two ſtripes were parallel one to another, and each pretty near equally diſtant from the upper and under part of the ſheath. I take for the under part *that* which covers the belly, and for the upper what covers the back.

It remained to know in what manner the moth undertook to make theſe enlargements along the whole length of each ſide of her ſheath. By diligent obſervance at different times, I perceived the manner ſhe ſets about it to be preciſely the ſame as we ſhould undertake in the like caſe: we ſhould not know what elſe to do, in order to enlarge a garment too narrow, than to cut it through its whole length, and to put *in* a piece of a ſuitable bigneſs between the parts ſeparated; we ſhould put *in* a like piece on each ſide, if the ſhape, ſuch as the moth's is, in the figure of a tube, required it. Now *this* is the very thing done by our inſects, with this precaution moreover, which is neceſſary to them, in order to prevent their being naked whilſt they are at work in enlarging their garment; that inſtead of two pieces, which ſhould have each the whole length of the ſheath, they put in four, which have each only half the length. By this means they cut through no more than the half of their *ſheath* at a time, *the reſt* is ſufficiently ſupported, and gives them a ſhelter till they are able to cloſe the part that is ſeparated. I have ſeen *ſome* that began to make the *ſlit* in the middle, and carried it *on* to one of the ends of the ſheath. The ſame talons, that they make uſe of for pulling up the nap of the cloth, are the tools which they employ in ſlitting their ſheath. They cut it ſometimes

times ſo exactly in a ſtraight line, the two edges of the ſlit are ſo little fringed, that *we* could not do it better with ſciſſars or a razor: the ſlit hath not the leaſt appearance of being made by *tearing*, no thread juts out beyond the others.

I have ſeen *others* that did not begin their ſlits neceſſary for the enlargement in *the middle*, but began *them* at the end or near the end, and carried them *on* to the middle. With regard to the time employed in each of theſe methods there is the utmoſt variety; neither every moth works alike, nor is the *ſame* moth in an equal humour for working. *Some* after having made an hole in the middle of the ſheath, have ſpent two hours in carrying *on* the ſlit to the end; others have done it more ſpeedily, and others more ſlowly; but none have been longer than from one day to another in putting *in* the piece that is to fill up the ſlit.

Their induſtry in lengthening and in enlarging their ſheath hath been ſufficiently explained, but we have not perhaps clearly enough ſhewn what is the texture of the ſtuff of which it is made. At the firſt ſight one perceives that ſhagged wool is the principal material, but we have already ſaid that more attentive obſervation diſcovers that ſilk likewiſe enters into its compoſition, that its *external ſtratum* is of wool and ſilk, that its *internal* is of pure ſilk. How is *this* lining

of ſilk applied? By what artifice are the little bits of wool united together? The whole mechaniſm is unravelled as ſoon as it is known that our inſects *ſpin*, and that they are in a condition to ſpin as ſoon as they are born. The thread that is ſpun iſſues from a little beneath the head, like *that* of caterpillers. It is ſo *fine* that it is with difficulty perceived, unleſs by a good microſcope; it is ſtrong enough however to keep the inſect ſuſpended in many circumſtances, and by this *effect* alone is it known at firſt that there is ſuch a thread. With this ſilken thread the inſect ties together the different bits of wool which compoſe the ſheath, inſomuch that the texture may be compared to a ſtuff, whoſe warp ſhould be of wool, and woof of ſilk. It is not eaſy to ſee whether it is interwove ſo regularly as we ſhould do in the like caſe; but it is certain that *we* ſhould ſcarce be able to make it ſo cloſe and compact. Perhaps it is not ſo neceſſary to be interwove; inſects that ſpin have an advantage which *we* have not; the threads that are but juſt come out of their body are ſtill gluiſh; it is ſufficient only to apply and preſs them againſt other threads, in order to attach them firmly together. It is probable however that the moth does interweave her threads with the threads of the wool, and is not content with gluing them one to another; one ſees the hole that is underneath her mouth furniſh,

niſh, as the ſhuttle would do, a thread proper for interweaving; and one ſees her head perform quick and lively motions in oppoſite directions. The ſame thread that forms the woof of the ſuperior texture, being interwoven *ſingly*, in the manner that caterpillers work the threads with which they compoſe their cods, forms the texture which ſerves for a lining.

In their common labour one cannot diſcover whether the inſect begins by making that part of the texture, which conſiſts of wool and ſilk, or by *that* of pure ſilk. But you may force them to reveal their whole procedure by conſtraining them to cloath themſelves anew. In order to force them to *that*, I have introduced into one of the ends of the ſheath a little ſtick pretty near equal in diameter to the body of the inſect, and puſhing the ſtick have obliged the animal to give way, ſo that by little and little I drove her out of her *caſe*. The moth being *thus* made naked was under a neceſſity of covering herſelf anew. She had the courage to undertake it, notwithſtanding what Pliny ſays, who affirms that they die if taken out of their ſheath; which may be true, if all the precautions I took be not carefully obſerved. In divers experiments of the like kind that I have made, the moth hath always choſe rather to make herſelf a new habit, than to return back into *that* ſhe hath quitted, which coſt her

her ſo many months labour. In vain have I placed their ſheaths near them, I never ſaw *any* make an attempt to enter them. *Some*, after having been ſtript, continued half a day reſtleſs, wandering, and at length determined themſelves. They began with ſpinning a *covering*, which was ſomewhat whiter than the cobweb of houſe-ſpiders, but pretty near of a like conſiſtence; this cover was commonly finiſhed in one night: in five or ſix days at moſt the ſilken ſheath was entirely covered over with wool. Thus in a few days ſhe performed the work that ſhe is not accuſtomed to finiſh under ſeveral months. The moths forced to cloath themſelves quite anew, ſet about it preciſely in the ſame manner as when they were but juſt born. I have obſerved ſuch as had been hatched only a day, begin with making themſelves a ſheath of pure ſilk. I have ſeen them afterwards attach to the middle, and all round this ſheath, a ring of woolen threads laid parallel one to another, and inclined a little along the length of the ſheath. The reader will eaſily imagine that the aſſiſtance of a good glaſs is neceſſary for the obſervance of theſe particulars. Our little inſects afterwards lengthened that ring by a new range of woolen threads, and ſo continued joining to each rim of the preceding ring a new ſucceſſive range of threads, united by her *home-ſpun* ſilk.

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The habit that a new-born moth, ſmall as ſhe is, makes for herſelf, is always exceſſively too big, as if ſhe was willing to ſave herſelf the trouble of enlarging it ſoon. Indeed they hang quite looſe in their garment. I have ſometimes ſhaken a little piece of cloth covered with moths, that had newly dreſs'd themſelves, upon another piece of cloth on which I had a mind to make them work, and I found none but naked moths fall off.

As theſe inſects are transformed into butterflies, there are every year a great number of *caſt-off* ſheaths; the young moths appeared to me to prefer the wool, with which *thoſe* had been made, to *that* of ſtuffs; *there* they find materials prepared, and the threads of wool already cut of a proper length. The new-born moths ſeem to affect chiefly a white wool, and pick out the threads, that may be diſcerned by a microſcope even in coloured cloths to be undied; as they become older, they grow fond of party-coloured dreſs.

On certain days, particularly in the winter ſeaſon, our inſects lie idle; they have likewiſe their holy-day times, but ſhorter, in the ſummer and autumn; *then* they fix their ſheaths upon a ſtuff they have nibbled before. If the ſheath was merely *laid* upon the ſtuff, it might be thrown on the ground by a thouſand accidents; but the inſect *fixes* it in ſuch manner, that there is nothing to fear. He faſtens at each end of the ſheath ſeveral bundles

bundles of threads, which are all glued at the other extremity to the ſtuff; *theſe* are ſo many ropes, as I may ſay, for keeping the ſheath at anchor.

The wool of our ſtuffs not only furniſhes them with cloathing, but furniſhes them likewiſe with food; they eat and digeſt it. If it be remarkable that their ſtomachs ſhould digeſt and diſſolve ſuch ſubſtances, it is no leſs remarkable that they ſhould occaſion no alteration in the colours with which the wool hath been dyed. The excrements of theſe inſects are little grains, which have preciſely the colour of the wool on which they have fed. There are no *ſands*, in the cabinets of the curious, that ſhew ſuch diverſities of colours, as the excrements of moths that have lived upon hangings which have varieties of colours.

At length, when they are come to their perfect growth, when the time of their metamorphoſis approaches, they often abandon theſe wooly ſtuffs that had furniſhed them till *then* with food and raiment; they ſeek *places* that can afford them more firm defence than tiſſues which may be ſhaken by every breath of wind. *Some* go and eſtabliſh themſelves in the corners of walls, others clamber up to cielings: thoſe that in the courſe of the year had ravaged the ſeat and back of elbow-chairs, neſtle themſelves *then* in the little chinks between the ſtuffing and the wood:

thoſe

thoſe that I have kept incloſed in bottles whoſe mouths were very open, have commonly been collected under the lid. Whatever *place* they have choſen, they faſten to it their ſheath, moſt commonly at both ends, but ſometimes only at one end; ſome fix it parallel to the horizon, others in angles variouſly inclined: it did not appear to me that they are particularly fond of any poſition. One thing they never fail to do, which is, to cloſe well the openings of the two ends of their ſheath with a ſilken web. The inſect *thus* incloſed very ſoon changes her form, ſhe takes *that* of a chryſalis, which is at firſt of a white *ground* lightly yellowiſh, and paſſing ſucceſſively through deeper *tints*, becomes a reddiſh yellow. After having continued a chryſalis *ſome time*, the preciſe duration of which I do not know, but it doth not exceed three weeks, ſhe pierces a hole in one of the ends of the ſheath wherein ſhe incloſed herſelf; ſhe advances forth her body half way, ſtill under the *form* of a chryſalis, but is to keep *it* no longer than a few hours, for ſhe breaks through that yellow-coloured covering which gave her that *form*; and then you ſee her ſally forth, and fly away a whitiſh-grey butterfly.

Amongſt *theſe* butterflies, as well as amongſt *thoſe* of other ſorts, there are males and females. The difference of bigneſs, that in many of the claſſes of butterflies diſtinguiſhes

guiſhes the male from the female, is not perceivable in *theſe*. We find indeed butterflies *from* moths of very different bigneſs: but theſe different ſizes are rather marks of a different ſpecies, than of a different ſex.

Methods of deſtroying moths.

Having ſeen with how much art the moths array themſelves, I cannot help lamenting that they ſhould be *thus* ingenious at our expence, and that we ſhould be obliged to declare war againſt ſuch induſtrious inſects. I learnt their genius by ſeeking methods to deſtroy them, and ſhall now reveal to the reader the poiſons and deſtructive arts that my enquiries have diſcovered.

It is the common cuſtom in houſes, where they are careful of their furniture, to take down the hangings and beds *once* in a year, to have them beat and bruſhed. This method alone would be an excellent preſervative againſt theſe inſects, if it was but made uſe of at a proper ſeaſon, which is when the young moths are juſt hatched, and there remain no more old ones, *namely*, about the middle of Auguſt, or at the lateſt in the beginning of September. It would be of little ſervice to beat and bruſh the furniture at any other ſeaſons; the inſects, in a little time after they are born, neſtle themſelves ſo far *in*, and faſten themſelves ſo tight, that the bruſhing would ſweep off but few.

Modern naturaliſts, who have neglected to *obſerve* theſe inſects, have not neglected to

teach us *ſecrets* for preſerving our ſtuffs againſt them; the only misfortune is that they never gave themſelves the trouble to make trial of their ſecrets. You find great ſtore of them, and pretty much the *ſame* in Aldrovande, Jonſton, Mouſet, as *thoſe* related long before by Cato, Varro, and Pliny. Mouſet pretends to prove that the ancients had a certain preſervative, by the dreſs of Servius Tullius, which was preſerved till after the death of Sejanus, that is to ſay, for more than five hundred years. If amongſt the ſecrets which have been left to us there are *ſome* good, there are many *others* fit only to make the reſt ſuſpected. Pliny, immediately after telling us that thoſe, who have been ſtung by a ſcorpion, have nothing to fear *ever after* from waſps, bees, and hornets, adds that we ſhall be leſs ſurpriſed at this marvel, when we know that an habit put upon a coffin is *for ever* protected from the teeth of moths. Rhaſis, after having ſaid that cantharides ſuſpended in a houſe keep *them* away, adds that habits wrapt up in a lion's ſkin are perfectly ſecure from *them*; the ſkin alone of ſo terrible an animal appeared to him ſufficient to frighten away ſuch little inſects. What hath been related in theſe different authors of the effect of various odoriferous plants, will appear to deſerve *better* our putting them to the trial. We find in their works that ſavin, myrrh, wormwood, orrice, citron peel, aniſeed,

ſeed, and divers others, put amongſt ſtuffs, keep off the moths. Cato deſcribes a preparation of olive-lees, with which he would have the coffers rubbed, wherein clothes are to be kept, and by which he aſſures us they are afterwards ſecure.

I have been far from neglecting to try the ſecrets that have been tranſmitted to us; yet thought I might without any danger of reproaches neglect the trial of *habits* put on a coffin, or wrapt up in the ſkin of a lion.

A reflection on a well-known fact directed me to try a method of making our ſtuffs diſagreeable to theſe inſects. We never find any moths attach themſelves to the fleeces that are on the *backs* of ſheep; if *that* wool was to their taſte, it is probable they would lodge *there*, as another inſect *does* which Rhedi hath deſcribed. Butterflies would go and depoſit their eggs upon the fleeces, they would have nothing to fear from the pacific animals that bear them; it would not be requiſite for them to have the boldneſs of a ſort of fly, that even chuſes the inſide of the noſtrils of ſheep to lodge its *young* in; *there*, being moiſtened continually by a proper liquor, *they* grow till they are in a condition to be metamorphoſed into flies: we have this account in the curious hiſtory of this inſect, publiſhed by Mr. Valiſnieri. Other flies go and wound animals covered with hair, they leave their eggs or *young* in the wounds they have

have made in their ſkin, where *they* grow like the worms of the galls or excreſcences of trees, till they are ready to be metamorphoſed.

The remark we have made extends itſelf to all the *ſkins of animals* that are covered with hair. *They* would in a great meaſure be always *bare*, if the moths eſtabliſhed themſelves *there* as willingly as they do, when we have manufactured *them*.

Let us carry this remark ſtill further. *Fleeces* ſhorn from the ſheep, which have not received any of thoſe preparations that we give them in order to employ them for our uſes, are not much more ſubject to be nibbled by the moths, than when *they* covered the ſheep. The ſame thing is true with regard to furrs; before *they* are dreſſed, the moths very ſeldom attack them.

By preparing wool and ſkins for our uſes, we prepare them at the ſame time for moths; the firſt dreſſing we give them makes them a food agreeable to theſe inſects. The wool that hath not received any preparation is called *greaſy-wool*, it is *ſo* to ſuch a degree that the fingers grow greaſy by touching it. The firſt work upon it conſiſts in clearing it of its *greaſe*; and as ſoon as it is ſcoured from *that*, the moths no longer ſpare it.

From hence it follows that in clearing wool from dirt and filth we ought to deprive it of its natural greaſe as little as poſſible: the

leſs hot the water is in which it is waſhed, the more you will leave of this greaſe; which can never do any miſchief, when you employ the wool only in white ſtuffs, ſuch as *blankets*, whoſe fate generally is to be cut to pieces by theſe inſects.

But wool and ſtuffs that you would dye muſt abſolutely be cleared of their greaſe: this put me upon trying whether a part of the *greaſe*, that had been taken from the wool, being reſtored to it again after it was dyed, would not make it diſagreeable enough to the moths, altho' it ſhould not be ſo much greaſed as to be perceptible by *us*. The manner of reſtoring back a part of the greaſe to the woolen ſtuffs is eaſy enough, it is but to take ſome hot water in which fleeces have been waſhed, and with a bruſh that hath been dipped in it, to ſkim over the ſtuffs you would preſerve.

I beg leave to obſerve that it was pretty much in the ſame method that they got the beauty waſh ſo celebrated amongſt the Roman ladies,

Pyxidas invenies, et rerum mille colores;
Et fluere in tepidos œſypa lapſa ſinus.
Ovid. Remed. Amoris, 353.

The ſucceſs anſwered my expectations; and this effect of their *natural greaſe* invited me to try whether other *greaſes*, whether mutton ſuet, which had been preſcribed as

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a preſervative againſt moths, whether butter, or oils of different ſorts might be employed with ſucceſs; but I found no greaſe or oily ſubſtance ſo diſagreeable to moths, as the natural greaſe of fleeces. Indeed it was reaſonable to preſume that the *ſecret*, which nature employs to preſerve the veſture ſhe gives to animals, is at leaſt *the beſt*. The *greaſe* of fleeces differs from *others* by a very ſtrong rammiſh ſmell, which remains on the fingers that have but lightly touched wool. I have tried ſome oils, which far from keeping moths away ſeemed only to make them more *licoriſh*, ſuch is the oil of nuts; they appeared on the contrary to *ſhun* the oil of olives; this laſt obſervation is favourable to the *recipe* preſcribed by Cato, which is nothing but a preparation of the lees of olives.

Greaſy ſubſtances were not the only things I tried, but all *that* others had taught and recommended, as well as *many* of my own contrivance; the reſult was that none of *them* proved abſolutely fatal to theſe inſects; that *ſome*, which had been delivered down to us as preſervatives, were by no means diſagreeable to them, but ſeemed rather extremely pleaſing; I ſaw no moths grow better nor nibble faſter than ſuch as had been put on cloth, together with a great quantity of orrice root, which is one of the plants preſcribed againſt them.

Moths placed on wool, offenſive to their taſte, have a reſort to which they betake themſelves. In caſe of neceſſity, their cloaths furniſh them with food; they yield to the moſt preſſing want, and chuſe to live better, and be worſe cloathed.

It is happy for them that they have ſtill another reſort for repairing the ravages they have committed on their garments, and they repair them ſo well that the ſight alone cannot diſcern any change, either in the texture or colour of the ſheath, which they have nibbled. The ſheath at firſt furniſhes them with food, and their excrements afterwards furniſh them with cloathing. Their excrements are little, round, dry grains, and preciſely of the colour of the wool, that the inſect hath digeſted. She faſtens theſe little grains together by threads of ſilk, and diſpoſes them in the *places* of the little bits of wool which ſhe had plucked up; thus the upper part of her garment preſerves its form and colour.

Sheaths thus repaired almoſt *intirely* by excrements were the means of my diſcovering, that ſome of the ſubſtances I have mentioned before occaſioned the moths to diſlike certain ſtuffs.

In different places of the country I have ſeen women perſuaded, that they preſerved their clothes very well from moths by putting pine-cones in cheſts of drawers or in coffers, where

where they kept them. Theſe traditions, which are commonly called *old womens notions*, are not always ſo deſpiſable as is thought; there are *ſome* that have an excellent origin, and which well examined into would be found extremely uſeful: at leaſt we have no right to reject *them* till our own trials of them have given us a right. Inſtead of pine cones I thought I might try ſomething better in the ſame kind: *they* have a reſinous ſmell; if *they* produce the effect that is attributed to them, it is probably owing to this ſmell. I thought it therefore better to try odours of *this kind*, but ſtronger and more penetrating than *that* of the cones. I rubbed one ſide of a piece of ſerge with a little turpentine; with oil of turpentine I lightly wetted one ſide of another piece of ſerge; and with each of theſe pieces I confined ſome moths.

The next day I found thoſe which had been with the oil of turpentine all dead, and by a violent death, which had been preceded by furious convulſive motions; the greateſt part were naked and ſtretched out ſtiff, having left their ſheaths, which they never quit, and in which thoſe that periſh in the courſe of the year are conſtantly found.

The compaſſionate reader perhaps already pities the poor inſects, that he foreſees deſtined to periſh in ſuch torture, in order to confirm the preceding experiment, to purſue the circumſtances of it, and to determine the

doſes of the oil of turpentine, which gives ſo ſpeedy or rather ſo ſlow a death.

To ſpare the reader the trouble, *and indeed the pain*, of reading the experiments that I made on this occaſion, I ſhall only mention that it is not neceſſary to rub with the oil of turpentine the furniture which you would preſerve from the moths; it is ſufficient to ſhut it up in *places* where there is a ſtrong ſmell of turpentine: you need only put pieces of paper or linnen, dipt in the oil, into cheſts of drawers or wardrobes, and leave them *there* for a day.

Being deſirous of deſtroying moths by ſome odour that is leſs diſagreeable to *ourſelves* than the oil of turpentine, I tried the ſmoak of tobacco, which had the deſired effect. By finding out methods of deſtroying moths, I diſcovered that the *ſame* would be inſtrumental in deſtroying other inſects. Caterpillers of all ſorts could no more reſiſt the penetrating odours of oil of turpentine and the ſmoak of tobacco, than the moths; all periſhed that had the misfortune to be ſubſervient to my experiments: flies, ſpiders, piſmires, ear-wigs, fell victims to my enquiries.

I was eager to try the power of theſe ſmells againſt inſects, of whom *we* may be ſaid to be in *bodily* fear; it is not our furniture, but ourſelves that bugs attack. The experiments I made proved that the ſmell of turpentine and the ſmoak of tobacco are capable of delivering

livering us from thoſe ſtinking and blood-thirſty inſects. Theſe odours ſuffocate them very ſoon, altho' not ſo ſoon as the moths.

In order to deſcribe the methods of diffuſing theſe odours in the moſt efficacious manner, I ſhall begin with *that* of tobacco. Fill ſome chafing-diſhes with charcoal not thoroughly kindled, upon which ſpread ſome handfuls of cut tobacco, ſuch as ſmoakers uſe. The number of chafing-diſhes muſt be proportioned to the extent of the room. The doors muſt be ſhut after you have placed the chafing-diſhes with all proper precaution againſt fire. Little ſtoves might be made uſe of with leſs riſk. If there be a chimney, you muſt hang a carpet or ſome thick coverlet before it, in order to prevent the ſmoak from iſſuing out. The windows likewiſe muſt be carefully faſtened down; the goods and furniture muſt be unfolded and opened as much as poſſible for the ſmoak to penetrate. A thick ſmoak of tobacco confined thus for 24 hours will have deſtroyed the moths: after *that* you may expoſe the goods to the air, in order to take off the ſmell of tobacco.

I beg leave to obſerve likewiſe, that great care muſt be taken that no body continues or enters into the room during the operation; and even after the operation the doors ſhould be thrown open, and left ſo a good while before any perſon ventures into the room; for the

ſmoak of charcoal alone is very ſuffocating, and hath been often found inſtantaneouſly fatal.

Furniture in which there is ſilver employed, and which has delicate colours, would be tarniſhed by the ſmoak of tobacco; for *ſuch* it will be better to have recourſe to the oil of turpentine; the effect of which will be the greater, as the ſmell is ſtronger. The ſtrength of its ſmell will be leſs proportioned to the *quantity* employed than to the *extenſion* of its ſurface: oil of turpentine contained in an open bottle, or even in a glaſs, will give a ſmell that is tolerable, but you would not be able to bear the ſame quantity of the oil diſperſed on the floor. Another circumſtance increaſes likewiſe the force of this ſmell, which is the degree of warmth in the air; the ſame quantity of the oil ſprinkled about a room in ſummer and in winter will not have an equal effect.

From what we have ſaid it follows that the quantity of oil of turpentine employed ſhould be extended in ſurface as much as poſſible. If you would apply it on the goods themſelves, which is the moſt ſimple and beſt way, pour ſome oil into a wide cup, dip lightly the end of a large pencil bruſh into it, and paſs it forwards and backwards over the ſtuff till the bruſh is quite dry, then dip the bruſh again into the oil and do it over in the ſame manner on new places of the ſtuff. If you *thus* bruſh the oil upon goods that are

hanging, you need only keep the doors and windows ſhut and the operation is finiſhed.

If the goods are *taken down* there will be no inconvenience in folding them up immediately after they have been rubbed with the oil; it will be even an advantage to do it immediately, eſpecially if after they are folded you lock them up in a cloſe preſs or cheſt of drawers.

There is nothing elſe to be feared with regard to the goods from this method of applying the oil of turpentine, but that the ſmell might continue longer than you would chuſe. When they have been well penetrated with it, you muſt avoid uſing them till they have been expoſed to the air for ſeveral days.

The ſmell will be leſs *durable*, if inſtead of rubbing the goods themſelves with the oil you only ſhut them up in places that have been well perfumed with it. You may, for example, rub all the inſide of a cheſt of drawers with oil, or place pieces of paper and linnen dipt in the oil in every drawer.

Whatever hopes of utility I may have raiſed by the obſervations I have made, yet the reader, I fear, will be tired of reading only of poiſons, racks, and tortures, for unhappy but induſtrious inſects. He will be pleaſed no doubt to hear of the compenſation I have to propoſe in favour of the moths. My ſcheme is to let them live and to get them to work

work for us as uſefully, as they have hitherto been employed to our injury. Worms furniſh us with ſilk; bees give us wax and honey; we owe the lacca, ſo uſeful for ſealing-wax and for varniſhing, to a kind of winged ant. Our painters, and particularly painters in water-colours, may get from moths colours of all kinds and tints, by turning to their advantage a ſingularity we have mentioned in the preceding account of moths. It is well known that the crayons for painters are prepared with a good deal of trouble; our moths would ſave us theſe preparations, and give us more beautiful as well as perhaps more durable colours. Their excrement has the colour of the wool, on which they have fed, and preſerves intirely the luſtre of it. It has the property likewiſe of being eaſily made up into a paſte. In order to have a beautiful red, yellow, blue, green, or any other colour, or ſhades of colour, you need only feed moths with wool of each of theſe colours; which may be done at a ſmall expence by giving them only the ſhearings of cloths.

I muſt obſerve moreover that the moths are ſo teeming that whatever quantity we ſhould want to breed for very large proviſions of colours, it might very eaſily be obtained. The product of each moth would not be great in a whole year, but the number of inſects, which might be multiplied, will give as ample a collection as our wants could require.

quire. Thus we ſhould have, without any expence, very beautiful, and I believe very laſting colours. The good colours of our cloths are as durable as one can deſire the colours of paintings to be. It is even probable that the colours, which have paſſed thro' the ſtomachs of theſe inſects, have acquired a greater perfection, for reaſons well-known by thoſe that underſtand the art of dying: but after all we muſt wait for experience.

Memoirs 1728, *pag.* 139 *and* 311.

The reſt of Mr. De Reaumur's treatiſes on inſects, which compoſe ſix volumes in quarto, and contain a noble collection of a curious part of natural knowledge, not having been preſented to the academy, do not fall within my province.

A ſurpriſing account of two toads.

There was found in the trunk of an elm tree of the bigneſs of a man's body, three or four feet from the ground, and preciſely in the middle, a living toad, of a moderate ſize, meager, and which had but juſt room enough to be contained there. When the timber was cloven, the toad got out and moved off very faſt. No elm could be ſounder, nor compoſed of parts more cloſe and compacted together; and the toad could not have entered by any inlet: the egg that formed it muſt have been by ſome particular accident lodged in the tree when young; the animal had lived there

there without air; and what is very ſurpriſing, had been nouriſhed from the ſubſtance of the wood, and had grown only in proportion as the tree grew. The fact is atteſted by Mr. Hubert, ſenior, profeſſor of philoſophy at Caen, who hath writ this account to Mr. Varignon.

Mr. Seigne of Nantes hath written to the academy an account of the ſame fact preciſely, except that inſtead of an elm it was an oak much bigger than the elm, which greatly increaſes the wonder. He judges by the time neceſſary for the growth of the oak, that the toad muſt have been preſerved *there* for fourſcore or an hundred years, without air or any other food than from the tree.

Hiſtory 1719, *pag.* 39. *Hiſtory* 1731, *pag.* 21.

Whether a toad will live abſolutely without air I do not know, having never made the experiment with the air-pump; but it is certain he will live where there is no free communication of air; and Virgil, the correcteſt writer of all the ancients, with great juſtneſs obſerves,

Inventuſque cavis bufo, Georgic. 1, 184.

I beg the reader's patience whilſt I take this opportunity of remarking another inſtance of Virgil's delicacy in the choice of his epithets, which hath eſcaped the notice of commentators and critics, in the ſixth book of the Æneid, ver. 107.

—Tenebroſa palus Acheronte *refuſo.*

The

The commentators have forced upon the word refuſo *in this place a ſignification not its own: in ſhort, they have given it the ſame ſenſe as the word* effuſus *properly bears. De la Rue in the Delphin edition interprets it* exundante. *By ſuch interpretations all propriety of expreſſion is entirely confounded. But the correct writers amongſt the claſſics did not uſe words in ſuch promiſcuous ſenſes; and I am ſatisfied that the word* refuſo *here in Virgil alluded to the doctrine of Plato concerning the rivers of the infernal regions, delivered in his Phædo, edit. Serrani, tom.* 1. *pag.* 112. *There he deſcribes theſe rivers as flowing from the ſhades to this upper world; and after having ſupplied the ſprings, rivers,* &c. returning back again *to thoſe realms of darkneſs.*

In this ſenſe there is a very juſt propriety in the epithet refuſus *applied to Acheron; and it is certain that Virgil very frequently alludes to Platonic notions in the uſe of a ſingle word. I need quote no other inſtance than that well-known paſſage in the ſixth Æneid:*

Igneus eſt ollis vigor, & cœleſtis origo
Seminibus—

The word ſeminibus *all commentators allow to be an expreſs alluſion to the doctrine of Plato.*

In like manner in the ſeventh Æneid, ℣. 225.

— ſiquem

—ſiquem tellus extrema *refuſo*
Summovet oceano,

The Delphin edition very wildly interprets it interfuſo ; *and De la Cerda ſays,* Ego capio longe, & late diffuſum, atque extentum. *But the true meaning is the natural ſenſe of the word, the* ebbing *ocean, to diſtinguiſh it from the Mediterranean ſea, and conſequently to expreſs the remoteſt diſtance. Refuſo oceano is put poëticé for oceano qui refunditur ; as inventuſque cavis bufo,* inventus, pro qui invenitur, Servius, *who rightly ſaw the ſenſe of the word* refuſus *in the ſeventh Æneid, and pointed it out ; but De la Rue (whoſe edition is ſo much boaſted of) either did not, or could not perceive it. Thus do commentators very frequently miſlead the reader, and ſtain the purity of claſſic authors by errors of their own. But I aſk pardon for this long digreſſion.*

The manner of preſerving eggs freſh for ſeveral years by Mr. De Reaumur.

The pleaſures of life amongſt the inhabitants of civilized countries, ariſe from an infinite number of little conveniencies and delights, that induſtry hath diſcovered by degrees the means of procuring. Not to mention all that the ſeveral arts have acquired in this kind, of how many delicious fruits ſhould we have continued deſtitute in France, if we had none but thoſe that the ſoil itſelf produced? Like the ancient Gauls we ſhould *ſtill* ſit down in ignorance and with religious awe beneath our venerable oaks.

It

It is almoſt within our own memory, that a new and excellent kind of bird, *namely* turkeys, hath been eſtabliſhed amongſt us, and hath been multiplied to ſuch a degree, that we have almoſt forgot that it is a *foreigner*. Within theſe few years we have begun to naturalize Guinea hens, with a probability of ſucceſs: what was at firſt the dainties of the rich, becomes at laſt the common food of all. Whatever can contribute to the happineſs of a great number of men, how ſmall ſoever the happineſs may be, is an object worthy our attention. For this reaſon I make no ſcruple of pointing out a method for preſerving eggs.

In the firſt memoir of the ſecond volume of my hiſtory of inſects I related ſome experiments, which prove indubitably that eggs may be preſerved for ſeveral months, or even years, in the ſame condition as when they were laid; that an egg of ſeveral months may have as good a taſte, and be as freſh, as one laid but a day.

An egg which was full when it came from the body of the hen, becomes leſs and leſs *ſo* as it grows ſtale. However compact its ſhell may appear to us, it is perforated by an infinite number of holes, which by their ſmallneſs eſcape our eye-ſight, but whoſe exiſtence is ſufficiently demonſtrated by the *void* that is made, and increaſes daily in the inſide of the egg. A watery moiſture tranſpires continually

tinually through thoſe pores of the ſhell, and it tranſpires more abundantly in hot weather than in cold. You may immediately draw from an egg enough liquor to moiſten its ſhell, you need only for that purpoſe put it into the pneumatic machine and pump out the air.

Now in order to preſerve an egg freſh, the only point is to keep it *full* or in other words to *prevent* the tranſpiration; and *this* is done by ſtopping up the pores with a mattter that cannot be diſſolved by an aqueous fluid. In a word, we have proved in that memoir I mentioned before, that any varniſh diſſolved in ſpirit of wine ſpread over the ſhell, would hinder the egg from waſting. We have even entered into a detail of calculations neceſſary to ſhew that this method would not be expenſive. But how little ſoever it may coſt, and however certain the ſucceſs, it will not be of uſe to the public, till recourſe ſhall be had to it for preſerving a very *great number* of eggs, till enough ſhall be varniſhed for ſupplying the continual conſumption.

However *ſimple* the compoſition is of the varniſh and the manner of applying it, the whole may appear too embaraſſing for country people and peaſants; yet *theſe* are the people we muſt put in a condition of preſerving our eggs. I have always been diſſatisfied with leaving *them* under a neceſſity of making or purchaſing varniſh, which is a kind of drug

drug that they do not ſo much as know. But the experiments I have made *ſince* have informed me that one may ſubſtitute in the place of varniſh a matter leſs dear, more known, and eaſy to get every where; that all hard *fat* was capable of producing the ſame effect as the varniſh. There is no country place where they may not eaſily get mutton fat, and I have found that eggs, which have been *done over* with this fat, are preſerved freſh as long as thoſe which have been covered with a varniſh.

The way of managing it is *this*, buy ſome pounds of this fat, and, that you may be ſure of having it pure, melt it yourſelf; after having made it ſufficiently liquid, ſtrain it through a linnen cloth; let it run into an earthen pot, in which it may be kept for making uſe of as often as you have occaſion. A pot that holds 4 or 5 pounds of the fat will contain an ample proviſion for a great number of eggs. Every time you would make uſe of it, you muſt put the pot before a gentle fire, and leave it *there* till the fat is become liquid again; then take away the pot from the fire, and plunge an egg into the fat, taking care that the fat touches every part of it; you need not leave it any time in the fat, for it will be ſufficiently ſmeared in an inſtant; thus ſucceſſively dip as many eggs as you will, and if they were freſh when you dipped them they will continue freſh for

above a year; but great care muſt be taken to envelop the egg with fat the very ſame day it was laid, and as ſoon as poſſible after it was laid.

This method of preſerving eggs is particularly uſeful for introducing into the kingdom new kinds of birds. I have proved in the memoir already cited that as long as the egg continues in the ſtate of a freſh egg, the embryo lives in it. The covering of fat is much more eaſily taken off than *one* of varniſh; you may dip the egg for a moment in hot water without the embryo's ſuffering any miſchief, as the heat, which would ſuffice to melt the fat, would not have the time to penetrate into the inſide of the egg: but probably you may be content with *taking off* the main part of the fat by ſcraping and rubbing the egg, the reſt will be performed by the hen that ſits on it. If my notions for tranſporting foreign eggs and hatching them here *at home* prove true, we may have parrots in our own woods, and our tables may be ſpread with dainties yet unknown.

That I have recommended the hard fat for preſerving eggs is only becauſe of all ſubſtances that can be employed it is the eaſieſt to get in all places, the cheapeſt, and with the leaſt difficulty to be *taken off*: but however it is evident that any other hard matter, which will hinder the tranſpiration of the egg, will preſerve it. I ſay *hard* matter, becauſe

cauſe oil for example, whoſe parts are not cloſely connected together, would not ſufficiently reſiſt the efforts of the water to evaporate from the egg.

Moreover what we have ſaid in general with regard to the preſervation of eggs, may be applied to the preſervation of many other ſubſtances of different ſorts, which have a diſpoſition to ferment.

Memoirs 1735, *pag.* 465.

Curious experiments on the effects of the preſſure of water at different depths in the ſea.

Mr. Coſſigny, an engineer and a correſpondent of the academy, hath made in the courſe of his voyage to the iſle of France, where he is employed, ſome experiments to ſee whether it is true, as hath been aſſerted, that the water penetrates into glaſs bottles which are plunged to the bottom of the ſea. It muſt be ſuppoſed that *they* are well *ſtopped*, and thoſe which Mr. Coſſigny made uſe of were *ſo* with an extraordinary care, and as much as is poſſible without being *hermetically* ſealed, for he could not get any of that kind.

At 180 fathom, the bottle was entirely broke to pieces by the weight of ſo great a depth of water; and, what is ſtill a more ſurpriſing effect, a piece of very ſtrong cloth *done over* with pitch and tar, which covered the cork ſtopple, and a piece of pack-thread which bound it down tight, were reduced to ſhreds.

At 60 fathom, the cork ſtopple was carried to the bottom of the bottle, the piece of *pitched* cloth, without being perforated or torn, was ſunk into the neck as far as a ſtrong ligature would permit, and the cloth could ſuffer an extenſion without burſting. The bottle came up again almoſt full of water, which after having forced down the cork had penetrated through the *pitched* cloth.

At 40 fathom, the bottle came up entire; nothing of *all* that had ſtopped it was put out of order, nor a drop of water in the inſide.

At 100 fathom, the ſame bottle, that had ſuffered nothing from the preceding experiment, came up likewiſe entire, but its cork, the outward end of which had been left much bigger than the neck of the bottle, that it might not be depreſſed, was notwithſtanding ſunk to the bottom of the neck, where it ſtopped. The *pitched* cloth was in like manner a little thruſt into the beginning of the mouth, without being torn. There was at the bottom of the bottle a little ſpoonful of clear water. This ſpoonful of water was very ſalt, although nothing ſurely was wanting to make a perfect filtration.

Hiſtory 1737, *pag.* 8.

Natural curioſities obſerved in a voyage to the polar circle, by Mr. de Maupertuis.

In order to determine with exactneſs the figure of the earth, it is neceſſary to compare together two degrees of the meridian the moſt diſtant in latitude that is poſſible; becauſe if theſe degrees go *increaſing* or *decreaſing*

ſing from the equator to the pole, the *difference* being too ſmall between neighbouring degrees might not be diſtinguiſhed from the *errors* of obſervations; whereas if the two degrees that are compared, are at great diſtances the one from the other, this *difference* being repeated as often as there are intermediate degrees, will make a *ſum* too conſiderable to eſcape the obſervers.

The count De Maurepas ſent orders to the academy from the king to determine the queſtion concerning the figure of the earth; the academy received them with joy, and haſtened to put them in execution by ſeveral of her members; ſome were to go beneath the equator, to meaſure the firſt degree of the meridian; others were to go to the north, to meaſure the moſt northern degree that was poſſible. The ſame ardour inſpired thoſe that were to expoſe themſelves to the burning heats of the torrid zone, and thoſe that were to feel the piercing horrors of the frozen clime: the ſame ſpirit animated all, the deſire of being uſeful to their country. The perſons deſtined for the north were four of the academy, *namely* Meſſ. Clairaut, Camus, le Monnier, and myſelf. There was in our company likewiſe the abbé Outhier; and we were joined by Mr. Celſius a famous profeſſor of aſtronomy at Upſal, who aſſiſted at all our operations, and whoſe lights and counſels were of great ſervice to us.

Vid map, plate 6.

The place of our *rendezvous* was Torne. We ſet out from Torne on Friday the 6th of July 1736, attended by a company of Finland ſoldiers, and a great number of boats loaded with *inſtruments* and things indiſpenſibly neceſſary for life. We went up the great river that riſes from the remoteſt part of Lapland, and empties itſelf into the Bothnic ſea, after having divided itſelf into two arms, that form the little iſland *Swentzer*, on which the city Torne is built, at 65 degrees 51 minutes latitude.

From *that* day we lived only in deſarts or on the tops of mountains, which we wanted to connect by triangles. After having gone up the river from nine o'clock in the morning to nine in the evening, we arrived at *Korpikyla*, which is a hamlet on the river's ſide; *there* we landed, and after having walked on foot ſome time acroſs the foreſt, we came to the *foot* of *Niwa*, a ſteep mountain, whoſe ſummit is nothing but a rock, up which we climbed and *there* pitched our tent. We had been upon the river very much incommoded with large flies, that have a green head, and draw blood wherever they ſting; we found ourſelves on the top of *Niwa* perſecuted by ſeveral other ſorts ſtill more ſanguinary. Two young Lapland girls were tending a little herd of rain-deer on the ſummit of this mountain, and we learnt from them the manner in which they protect themſelves

themſelves from the flies in this country; the poor girls were ſo involved in the ſmoak of a great fire which they had kindled, that we could ſcarcely ſee them; but we ſoon inveloped ourſelves with a ſmoak as thick as theirs.

Whilſt our company was incamped upon *Niwa*, I ſet out from thence the 8th of July at one o'clock in the morning, accompanied by Mr. Camus, to go and make our obſervations on the mountains towards the north. We went up the river as far as to the *foot* of *Avaſaxa*, a very high mountain; we felled the trees on its ſummit, and raiſed a ſignal. Our ſignals were hollow cones, built of ſeveral great trees, which being ſtript of their bark, made theſe ſignals ſo white that they could eaſily be diſtinguiſhed at 10 or 12 leagues diſtance.

As ſoon as our ſignal was built, we deſcended from the top of *Avaſaxa*, and having entered into the little river *Tenglio*, which throws itſelf into the great river at the foot of the mountain, we went up that river as far as the *place* which appeared to us the *neareſt* to a mountain, that we thought proper for our operation; there we landed, and after a march of three hours acroſs a moraſs, we arrived at the foot of *Horrilakero*. Although very much fatigued we got up to the top, and paſſed the night in cutting down the wood that was *there*. A great part of

the mountain is of a red ſtone with a kind of white cryſtals diſperſed up and down, that are long and parallel one to another. The ſmoak could not defend us from the flies, more terrible on this mountain than on *Niwa*. It was neceſſary notwithſtanding the heat, which was very great, to wrap our heads in *lappmudes* (which are gowns made of the ſkins of the rain-deer) and to be covered with a thick rampart of fir branches and even whole trees of fir, which almoſt ſtifled us, and did not *long* ſecure us.

After having cut down all the trees that were on the ſummit of Horrilakero, and raiſed a ſignal *there*, we ſet out and returned by the ſame road to our boats, which we had drawn up into a wood; for *thus* the people of the country ſupply the uſe of cordage, with which they are ill provided. It is true, that it is not difficult to draw, nor even to carry the boats which are made uſe of on the rivers of Lapland. Some very thin planks of fir compoſe a cock-boat ſo light and flexible, that it may ſtrike every moment the ſtones, of which their rivers are full, with all the force that the torrents give it, without ſuffering the leaſt damage. It is a ſight terrible to thoſe that are not uſed to it, to ſee in the midſt of a cataract, which ſtuns you with its roaring, this weak machine hurried away by a torrent of waves, foaming, and tearing up the ſtones; ſometimes toſt into the air, and

ſometimes

ſometimes loſt amidſt the billows: an intrepid Finlander ſteers it with a large oar, whilſt two others ply with all their force the oars, to eſcape from the waves purſuing, and every moment threatning to overwhelm them. The keel is often aloft in air, and only reſts at one end upon a wave that continually rolls away.

We re-embarked on the river *Tenglio*, and having got back into the river of Torne we went down it, in order to return to *Korpikyla*. At 4 leagues diſtance fron *Avaſaxa* we quitted our boats, and having marched about an hour in the foreſt we got to the foot of *Cuitaperi*, a very ſteep mountain, whoſe ſummit is nothing but a rock covered with moſs; from whence the ſight extends itſelf very far every way, and from whence you ſee to the ſouth the Bothnic ſea. *There* we raiſed our ſignal, and could diſcern from thence *Horrilakero*, *Avaſaxa*, *Torne*, *Niwa*, and *Kakama*.

We continued afterwards to go down the river, which hath, between *Cuitaperi* and *Korpikyla*, moſt frightful cataracts. The Finlanders themſelves never fail to land at the place of theſe cataracts; but exceſſive fatigue had made us more diſpoſed to paſs them by boat, than to walk but an hundred paces. At laſt we arrived on the 11th in the evening at the mountain *Niwa*, where the reſt of our company had been fixed. They had ſeen our ſignals, but the ſky was ſo loaded with vapours

vapours that they had not been able to make any obſervations. I know not whether it is becauſe the continual preſence of the ſun above the horiſon makes the vapours to riſe, and that no night *precipitates* them; but for two months, which we continued upon the mountains, the ſky was always lowring, till the north wind came and diſſipated the miſt.

Two days after our return to *Niwa*, a very cold northerly wind having riſen, we were able to make the neceſſary obſervations.

On the 14th we quitted *Niwa*, and whilſt Meſſ. Camus, le Monnier, and Celſius went to *Kakama*, we came Meſſ. Clairaut, Outhier, and myſelf to the top of *Cuitaperi*, from whence the abbé Outhier ſet out on the 16th to go and plant a ſignal upon *Pullingi*. We made on the 18th ſome obſervations, which though interrupted by thunder and rain were finiſhed that evening: and on the 20th we ſet out from thence, and arrived at midnight to the top of *Avaſaxa*.

This mountain is at 15 leagues diſtance from Torne, on the edge of the river; the acceſs is not eaſy, you go up it through a foreſt, which reaches about half way its height; *there* the foreſt is interrupted by great heaps of ſteep and ſlippery ſtones; after which you find the foreſt again, which did extend itſelf quite to the top; I ſay, *did extend itſelf*, becauſe we had felled the trees that covered the top. The north ſide of it is a frightful precipice

precipice of rocks, in which ſome hawks had made their neſts; it is at the foot of this precipice that the *Tenglio* runs, which winds round the *Avaſaxa*, before it throws itſelf into the river of Torne.

From this mountain the view is extremely beautiful; no object confines the ſight towards the ſouth, and you diſcern a vaſt extent of the river; towards the eaſt the eye purſues the *Tenglio* into ſeveral lakes, through which it paſſes; on the north ſide the ſight extends to 12 or 15 leagues, and is terminated by a vaſt heap of mountains piled one upon another, in all the confuſion of a chaos.

We continued ten days on this mountain, during which *curioſity* procured us viſits from the inhabitants of the neighbouring country; they brought us fiſh, ſheep, and the wretched fruits that grow in thoſe foreſts.

I ſet out from thence for *Pullingi* in company with Meſſ. le Monnier, Outhier, and Celſius. The ſame day that we quitted *Avaſaxa*, we paſſed the polar circle, and arrived the next day the 31ſt of July about 3 o'clock in the morning at *Turtula*, which is a kind of hamlet, and where they were cutting the little barley and hay that grows there. After having marched ſome time in a foreſt, we embarked on a lake that brought us to the foot of *Pullingi*.

This is the higheſt of all our mountains, and its acceſs very difficult by the ſuddenneſs of

of its aſcent and by the height of the moſs, through which we had great fatigue to make our way. We arrived however on the ſummit at 6 o'clock in the morning; and our reſidence *there* from the 31ſt of July to the 6th of Auguſt was as toilſome as the aſcent to it. We were obliged to cut down a whole foreſt of large trees, and the flies tormented us to ſuch a degree, that our ſoldiers, who were a diſtinguiſhed troop even in Sweden (where there are ſo many brave ones) thoſe men that had been hardened by the greateſt toils were obliged to wrap their faces up in linnen; theſe inſects infected every thing we wanted to eat, in an inſtant all our proviſions were blackened by them: birds of prey half famiſhed kept fluttering round about us, in order to ſnatch away ſome pieces of mutton as we were dreſſing it.

The next day after our arrival on *Pullingi*, the abbé Outhier ſet out from thence with an officer of our ſoldiers to go and raiſe a ſignal towards *Pello*. On the 4th we ſaw a ſignal appear upon *Niemi*, which was put up by the officer; having taken the angles between theſe ſignals we quitted *Pullingi* the 6th, in order to go to *Pello*; and after having gone up four cataracts we arrived *there* the ſame day.

Pello is a village inhabited by ſome Finlanders, near which is *Kittis* the leaſt of all our mountains; *there* we raiſed our ſignal.

In

In going up this mountain we find a large ſpring of the cleareſt water, that iſſues from a very fine ſand, and in the greateſt cold of winter preſerves its liquidneſs. When we returned to *Pello* towards the end of winter, whilſt the ſea of the Bothnic gulf, and all the rivers, were as hard as marble, this water flowed as in the ſummer.

We were lucky enough to make our obſervations as ſoon as we arrived, and to continue upon *Kittis* no longer than the next day: we ſet out from *thence* at 3 o'clock in the afternoon, and arrived the ſame evening at *Turtula*.

For a whole month we had been inhabiting deſarts and the tops of mountains, where we had no other bed than the ground, or a hard rock, covered with the ſkin of a rain-deer, and ſcarce any other food than ſome fiſh that the Finlanders brought us, or which we caught ourſelves, with ſome ſorts of berries and wild fruits that grow in thoſe foreſts. Mr. le Monnier, whoſe health declined viſibly every day by this kind of life, and who had received very ſevere attacks upon *Pullingi*, being unable to ſupport it any longer, returned down the river, to go and recover himſelf at the houſe of the clergyman of Ofwer-Tornea, whoſe houſe was the beſt, and almoſt the only refuge in the country.

I ſet out at the ſame time from *Turtula*, accompanied by Meſſ. Outhier and Celſius, to

go

go acroſs the foreſt and find the ſignal that the officer had raiſed upon *Niemi*. This voyage was terrible; we *walked* at firſt, in leaving *Turtula*, as far as to a rivulet, where we took water in three little boats; but they navigated with ſo much difficulty amongſt the ſtones, that we were obliged every moment to get out and leap from ſtone to ſtone. This rivulet brought us to a lake ſo full of little yellowiſh grains, of the ſize of millet, that all the water was coloured by them. I took theſe grains for the *chryſalis* of ſome inſect, and ſhould imagine that it was of ſome of thoſe flies that perſecuted us. At the end of this lake, it was neceſſary to *walk* to another; that had the moſt charming tranſparent water, upon which we found a boat; we put into it the quadrant, and followed it on foot along the ſide of the lake. The foreſt was ſo thick on the ſides, that it was neceſſary to make ourſelves a paſſage with an hatchet, embaraſſed at each ſtep with the height of the moſs, and with the firrs that we found lying along in our way. In all theſe foreſts there are almoſt as many of theſe trees lying as ſtanding; the earth, which can let them grow to a certain point, is neither capable of nouriſhing them, nor deep enough to let them take a firm root, one half of them decay, or fall by the leaſt blaſt of wind. The foreſts are every where full of firrs and birch-trees *thus* rooted up; time hath reduced the

the birch-trees to a perfect *duſt*, without having cauſed the leaſt alteration in the *bark*; and one is ſurpriſed to find many of theſe trees that are pretty big fall to pieces by a touch. It is perhaps this *durableneſs* of the bark of birch-trees that gave the thought of making uſe of it for covering houſes; nothing could be more proper for this purpoſe. In ſome provinces this bark is covered with earth, which forms on the roof a kind of garden: there are ſome of theſe gardens on the houſes of *Upſal*.

After much fatigue in paſſing through this foreſt ſtrewed with ruins, we at laſt arrived on the border of a third lake, very large, and whoſe water was the moſt beautiful cryſtal in the world. We found *there* two boats, in which having put our inſtruments and baggage, we waited for their return on the border of the lake. The high wind, and the bad condition of the boats, made the voyage very long: however they returned, we went on board them, croſſed the lake, and arrived at the foot of *Niemi* at three o'clock in the afternoon.

This mountain, to which the ſurrounding lakes and all the difficulties we under-went had given the air of an *enchanted* place, would have been charming every where elſe but in Lapland; on one ſide a *wood* quite free from thickets, and the ground as ſmooth as the walks of a garden; the trees affording

ſhade,

ſhade, and not intercepting the view of the lake, that waſhes the foot of the mountain; on another ſide you ſee ſpacious rooms and retired grottos, that appear cut into the rock, but are open at the top: theſe rocks are ſo perpendicular to the horizon, ſo lofty and ſo even, that they ſeem rather the walls of a palace which is going to be built, than the rough workmanſhip of nature. We ſaw ſeveral times thoſe vapours riſe from the lake, which the people of the country call *Haltios* and which they take for *ſpirits* that are the guardians of mountains. This mountain was formidable on account of the bears, that we were told we ſhould find *there*; but however we ſaw none, and indeed it hath more the appearance of a mountain inhabited by fairies and *genii*, than by bears.

The next day after our arrival the *fogs* prevented our obſervations. On the 10th our obſervations were interrupted by thunder and rain; the 11th we completed them; having left *Niemi*, after repaſſing the three lakes we arrived at *Turtula* at nine in the evening. We departed from thence the 12th, and came to the clergyman's houſe at *Ofwer-Tornea* about 3 o'clock in the afternoon.

I ſet out the 13th with Meſſ. Clairaut, Camus, and Celſius, for *Horrilakero*. We went up the *Tenglio* in four boats; this river hath its cataracts more troubleſome on account of the ſhallowneſs of its water and the great

great number of ſtones, than for the rapidity of its ſtream. I was ſurpriſed to find on its borders, ſo near the frozen zone, as beautifully bluſhing roſes as grow in our own gardens. We arrived at nine in the evening at *Horrilakero*. Our obſervations were not finiſhed *there* till the 17th: and having ſet out from thence the next day we arrived in the evening at *Ofwer-Tornea*, where we all met together.

The moſt convenient place had been choſen for our *baſis*. But going up in the evening to the top of *Avaſaxa*, to obſerve the angles that were to connect this baſis to our *triangles*, we ſaw *Horrilakero* all on fire. This is an accident that often happens in theſe foreſts, where there is no living in the ſummer but in ſmoak, and where the moſs and firs are ſo combuſtible, that very often the fire catches and ſpreads itſelf over ſome thouſands of acres, ſo that the whole country appears in a vaſt blaze of flames, or is involved in a thick night of ſmoak.

As the fire of *Horrilakero* aroſe no doubt from the fire we had left *there* not well extinguiſhed, we ſent away 30 men to ſtop the flames by cutting off all communication with the neighbouring woods. Our obſervations at *Avaſaxa* were not finiſhed till the 21ſt. *Horrilakero* ſtill continued burning; It was quite darkened with ſmoak; and the fire that had deſcended into the foreſts below was

continually making new ravages. Some of our people having brought word that our ſignal at *Horrilakero* had been damaged by the fire, we ſent to repair it.

On the 26th of Auguſt having heard that our ſector, which we expected from England, was arrived at Torne, we haſtened *thither* to get this ſector and all the other inſtruments which we were to carry up to the top of *Kittis*; becauſe, as the ſeverity of the winter was more to be feared upon *Kittis* than at Torne, we were willing to begin our obſervations for the amplitude of the arc at this extremity of our meridian, before the violent froſts ſhould come on.

We ſet out from Torne the 3d of September with 15 boats, which made upon the river the greateſt fleet that ever had been ſeen *there*: we arrived the 9th at *Pello*, where we all met together.

Our frequent journeys forwards and backwards, during our abode of 63 days amidſt the deſarts, had furniſhed us with the moſt beautiful ſeries of triangles that we could poſſibly deſire. A work begun without knowing whether it would be feaſible, and, as I may ſay, at hap hazard, was become entirely ſucceſsful; in which it ſeemed as if we had been able to place mountains agreeably to our own fancy.

It was on Friday the 21ſt of December, the day of the winter ſolſtice, a day remarkable

able for ſuch a kind of work, that we began the meaſure of our baſis towards *Avaſaxa*, where it lay. The ſun at that time of the year, did but juſt riſe above the horizon about noon; but the long twilights, the whiteneſs of the ſnow, and the *lights* with which the ſky is always illuminated in thoſe countries, gave us every day ſufficient light for working four or five hours.

We ſet out at 11 o'clock in the morning from the clergyman's houſe at *Oſwer-Tornea*, where we lodged during this whole operation; we went upon the river, where we were to begin the meaſure, with ſuch a number of ſledges (called traîneaux) and with ſo great an equipage, that the Laplanders came down from their mountains, attracted by the novelty of the ſight. I ſhall ſay nothing of the fatigues and dangers of this operation; the reader will eaſily imagine what it muſt be to march in ſnow two feet deep, loaded with heavy poles, which we muſt continually lay down upon the ſnow and lift up again; and *this* during a froſt ſo violent, that the tongue and lips froze inſtantly to the brim of the cup and could not be ſeparated without tearing off the ſkin, when we took a little brandy, which was the only liquor we could keep from freezing. Whilſt the extremities of our body were dead with cold, the toil made us *ſweat* in the reſt of our body. Brandy was not ſufficient to quench our thirſt, it was neceſſary

to dig in the ice deep wells, which were no ſooner opened than they cruſted over again, and we could ſcarce get the water faſt enough to our mouths to be *ſtill* liquid. Beſides all this we run great riſk of having mortifications enſue from our limbs being frozen.

Our work however advanced very happily; ſix days labour had brought it ſo far, that there remained no more to meaſure than about 500 fathom, which we had not been able to plant with ſtakes ſo ſoon as we wanted. Our meaſuring therefore was interrupted the 27th, and Meſſ. Clairaut, Camus, and le Monnier went to plant theſe ſtakes: in the mean time, the abbé Outhier and I employed this day in a very extraordinary adventure.

An obſervation of the ſlighteſt conſequence had been forgot in the ſummer; we had neglected to take the height of a certain object, which we had made uſe of on the top of *Avaſaxa*, in taking the angle between *Cuitaperi* and *Horrilakero*. The deſire we had that nothing ſhould be defective in our work, made us carry our exactneſs to a ſcrupulous nicety. I undertook therefore to get to the top of *Avaſaxa* with a quadrant.

Let the reader imagine to himſelf a mountain extremely high, full of rocks, that were now concealed from the ſight by the prodigious quantity of ſnow, which likewiſe covered the *hollows* where one might eaſily be ſwallowed up, and he will ſhudder at the thoughts

thoughts of mounting ſuch a precipice amidſt ſuch horrors. There are however two ways of accompliſhing it; the *one* by marching or rather ſliding on two narrow planks about 8 feet long, which the Finlanders and Laplanders make uſe of, to prevent their ſinking into the ſnow; but it is a manner of travelling that requires long exerciſe to be able to perform it. The *other* method is by truſting yourſelf to the rain-deer.

Theſe animals can draw but a very little boat, which will ſcarce admit the half of a man's body; this boat which is made for navigating in ſnow, in order to meet with leſs reſiſtance from the ſnow which it muſt cleave with its prow, and on which likewiſe it muſt ſlide, hath a *pointed* prow and a *narrow* keel; which indangers its rolling and overturning continually, if he that is within it is not very attentive to preſerve the equilibrium. The boat is faſtened by a thong to a breaſt-leather of the rain-deer, who runs with fury upon a beaten and ſolid road. If you want to ſtop him, it is to no purpoſe to pull a kind of bridle that is faſtened to his horns; intractable and untamable he only changes perhaps his road; ſometimes he runs back and revenges himſelf by kicking up behind. In that caſe the Laplanders have the dexterity to throw their boat over them, and make uſe of it as a buckler againſt the fury of the rain-deer. As for us, who were not capable

of this dexterity, we ſhould have been killed before we could have put ourſelves in a condition of defence. All our guard was a little ſtick which was put into our hands, and which we made uſe of as a rudder to ſteer the boat, and to avoid the trunks of trees. In this manner committing myſelf to the rain-deer I ventured to mount *Avaſaxa*, accompanied by the abbé Outhier, two Laplanders, a Lapland woman, and Mr. Brunnius the clergyman. The firſt part of the journey was performed in an inſtant; there was an hard and beaten road from the clergyman's houſe to the foot of the mountain; the rain-deer went it with a ſwiftneſs exceeding *that* of any *other* four-footed animal, and can be compared to nothing but the flight of a bird.

Ocior cervis, et agente nimbos
Ocior euro.

Altho' the mountain, up which there was no track, retarded the rapidity of the rain-deer, they conveyed us quite to the ſummit; and we quickly made the obſervation, for which we went. In the mean time the rain-deer made deep holes in the ſnow, and fed upon moſs, with which the rocks of that mountain are covered. The Laplanders that accompanied me had kindled a great fire, to which we ſoon came to warm ourſelves along with them. The cold was ſo great that the heat of the fire could not extend itſelf to the

leaſt

leaſt diſtance; if the ſnow melted in the places that were touched by the fire, it froze again all round, and formed an icy hearth.

We now were under another terror, of falling down headlong in our return from this craggy mountain, drawn in vehicles by animals that were ungovernable, even on a plain; but not to detain the reader with the horrors that are too great to be deſcribed, we were brought down in an inſtant to the foot of Avaſaxa, traverſed the great river, and in a moment arrived at the houſe.

The next day we completed the meaſuring our baſis; and we had no reaſon to repent the difficulties we had undergone in performing ſuch a work on a river that was frozen, when we perceived the *exactneſs* that our meaſuring upon ice had afforded us: we had divided ourſelves into two companies and made two ſeparate meaſurings; the difference between the two meaſures was no more than 4 inches upon a diſtance of 7406 fathom and 5 feet; an exactneſs that we could not hope to find, and ſcarce dare to relate.

After this operation we made haſte to get to Torne, that we might ſhelter ourſelves from the ſeverity of the winter.

The city of Torne, at our arrival the 30th of December, had truly a frightful appearance; its low houſes were ſunk quite to the roof in ſnow, which, had there been any day-light, muſt have hindered the entrance

of it by the windows: but the ſnow continually falling or hanging in the air, ſcarce ever permitted the ſun to appear, for the few moments he is above their horizon about noon.

The cold was ſo great in the month of January, that our mercurial thermometers of Mr. De Reaumur's conſtruction, thoſe thermometers which we had been ſurpriſed to ſee fall to 14 degrees below the freezing point at Paris in the greateſt froſt of the ſevere winter in 1709, now fell 37 degrees below it; the thermometers with ſpirit of wine were frozen. When one opened the door of a warm chamber, the cold air from without immediately turned into ſnow the vapour that aroſe from the breath of perſons in the room, and formed large and white flakes. When you went into the open air, it ſeemed to rend the breaſt aſunder. We were threatened every moment with an increaſe of cold by the cracks and ſplittings of the timber, of which all the houſes in that city are built. To ſee the deſolateneſs in the ſtreets, you would have thought all the inhabitants of the place were dead. One frequently ſees in Torne people maimed of a limb, an arm, or a leg, by the cold.

The cold, though always great in theſe countries, yet often of a ſudden increaſes ſo much as to be fatal to thoſe who are expoſed to it; ſometimes there riſes all at once a tem-

peſt

peſt of ſnow, which is ſtill more dangerous; the wind ſeems to blow from all quarters of the ſky at once, and drives the ſnow with ſuch impetuoſity, that in a moment all the roads are loſt from your ſight. Whoever is caught in ſuch a ſtorm in the country, would in vain hope to find his way by his knowledge of places, or by marks he had made of trees, &c. he is blinded by the ſnow, and is in danger of being ſwallowed up in ſome pit if he offers to ſtir a ſtep.

Although the earth appears dreadful at this ſeaſon of the year in theſe climates, yet the ſky preſents you with one of the moſt charming ſights in the world. As ſoon as the long nights begin, you ſee the ſky illuminated by lights of a thouſand ſhapes and colours, that ſeem deſignedly to make this climate amends for the abſence of the ſun. Theſe lights in this country have no conſtant ſituation, as they have in our ſouthern countries: although you may often ſee a *luminous arch* fixed towards the north, yet they ſeem moſt commonly to poſſeſs the whole extent of the hemiſphere: they begin ſometimes by forming a kind of mantle of a bright and moving light, which hath its extremities in the horizon, and ſpreads itſelf rapidly thro' the ſky, with a motion reſembling *that* of the drag-net of fiſhermen, preſerving in this motion very perceptibly a perpendicular direction to the meridian. Moſt commonly

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after theſe preludes, all theſe lights come and unite together towards the zenith, where they form the ſummit of a ſort of crown.

The *figures* theſe lights aſſume, and their *motions*, are ſo various, that it is impoſſible to enumerate them: but their moſt common motion makes them reſemble military *colours* waving in the air; and by their different tints of colours one would take them for ſo many *ſtreamers* of a *changeable* taffety; ſometimes they line ſome parts of the ſky with ſcarlet. I ſaw one day at *Oſwer-Tornea* (it was on the 18th of December) a ſight of this kind, which engaged my admiration, notwithſtanding my being ſo long accuſtomed to wonders. I ſaw towards the ſouth a large region of the ſky coloured with ſo lively a red, that it ſeemed as if all the conſtellation of orion was bathed in blood. This *light*, fixed at firſt, began very ſoon to move; and after having taken other colours, violet and blue, it formed a *dome*, the ſummit of which was a little inclined to the ſouth-weſt of the zenith; an extremely bright moon-light did not in the leaſt efface any thing of this ſight. I never ſaw but two of theſe *red* lights, which are rare in this country, *where* there is ſuch abundance of ſo many other colours. Whenever *they* are ſeen, the people apprehend ſome direful diſaſter. No wonder that *thoſe* who look at them with other eyes, than philoſophic ſight, ſhould perceive flaming chariots,

riots, fighting armies, and a thouſand other prodigies!

In the month of May, whilſt ice ſtill continued on the river, the ſun had approached ſo near us that he ſcarce ſunk beneath the horizon; it was a ſingular ſight to ſee him *ſo long* enlighten an horizon that was covered with froſt, to ſee, as I may ſay, *ſummer* in the ſky, whilſt *winter* was on earth. We were then in the morning of that great day which continues ſeveral months, yet it did not appear that the conſtant ſun cauſed any change in our froſt and ſnow. On the 6th of May it began to rain, and we ſaw ſome water on the ice of the river. Every day at noon the ſnow diſſolved, and in the evening the cold faſt bound it up again. At length, on the 10th of May, we ſaw the *earth* which had been ſo long concealed from our ſight: ſome elevated points of land, that were expoſed to the ſun, began to appear; and I could not forbear comparing this view to the aſſuaging of the waters after the flood, when *the tops of the mountains were ſeen.* Soon *after*, the birds began to warble, and all the face of nature broke into ſmiles of joy.

Memoirs 1737, *pag.* 390.

N. B. *I have not troubled the reader with the detail of mathematical operations in the proceſs of their work, nor with the aſtronomical tables and obſervations; it is*

is sufficient to remark that they all concurred to the immortal glory of Sir Isaac Newton, and to the establishment of his theory concerning the flatness of the earth towards the poles.

Observations of natural curiosities at Peru, by Mr. Bouguer.

The persons destined for the voyage to Peru, in order to determine the figure of the earth, were three of the academy, Mr. Godin, Mr. de la Condamine, and myself; Mr. de Jussieu, who hath since our departure been made a member of the academy, was joined to us, and appointed particularly to attend to the natural history of the countries through which we should pass; which task he hath executed with great care. A great many others were assigned assistants to us for making drawings, for calculations, and for discovering countries.

We embarked the 16th of May 1735 in the road of Rochelle aboard a man of war. After a pretty long stay at St. Domingo, we set out from thence the 30th of October for Carthagena. From thence we went to Portobello, and having travelled across the isthmus, we embarked at Panama on the South-sea, and arrived on the coast of Peru the 9th of March 1736, casting anchor in the road of Manta. Here Mr. de la Condamine and I separated from the rest of the company, because we thought we might make good use of our time in this part of the coast, where

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the heavy rains had already ceaſed; whereas we were told that they would continue, yet a good while, *further* towards the ſouth, and that the road of Quito would be unpaſſable till the month of June.

Mr. Godin ſet ſail again with the reſt of the company to go and land at Guayaquil. We had no reaſon to repent the choice we had made of landing *here*; it gave us the opportunity of getting a perfect knowledge of this coaſt, which being the moſt weſterly of all South America was neceſſary to be known with a particular exactneſs.

This country cannot fail of being extremely hot, ſince it is on a level with the ſea, and placed in the midſt of the torrid zone; it hath forty or forty-five leagues breadth, which is the diſtance of the Cordilleras (or Andes) from the ſea. Sometimes the coaſt changes ſuddenly its direction, and as if the chain of mountains had perceived the ſhifting trick, although at ſo great a diſtance, they ſeem to humour and conform themſelves to it; but moſt commonly they run in a ſtraight line, inſomuch that they are at a leſs diſtance from the ſea, when ſome gulf, ſuch as *that* of Guayaquil for example, enters conſiderably within land. Beyond this laſt mentioned gulf in going to the ſouth towards Lima, the country is quite different; you find nothing but ſands, which the ſea ſeems to have depoſited *there*, or to which one might give a

quite

quite contrary origin, by ſuppoſing that they have fallen from the Cordilleras; the country is entirely bare, no wood grows on it as on this ſide the gulf: but what diſtinguiſhes ſtill more this part of Peru which is beyond Guayaquil is, that it never rains *there*, although the ſky is very often cloudy. This particularity gives riſe to a problem in phyſics, which is by ſo much the more embarraſſing, as its ſolution depends on a more perfect knowledge of the nature of clouds, than the world at preſent hath: but it would be neceſſary to take up things at their very ſource, in order to give all the clearneſs neceſſary to the explication of this phenomenon. The narrow bounds within which I am obliged to confine this public recital, oblige me to defer my obſervations upon it to another opportunity.

After having made divers excurſions in this country, which is ſo little inhabited that the villages of Indians or Spaniards are often fifteen or twenty leagues diſtant from each other, and ſometimes a great deal more, it was neceſſary to think of making the beſt of our way to Quito, the roads of which began to be paſſable by the ceſſation of rains.

Mr. De la Condamine and I agreed to take different roads, that we might enlarge our remarks; we were then at the mouth of a river called *Rio-Jama* which is no more than nine minutes diſtant from the equator in the ſouthern

ſouthern latitude, and is almoſt on the ſame parallel as Quito. Mr. De la Condamine purſued the coaſt in going by ſea northward quite to the mouth of the river of Emeralds, which he went up and made a map of the whole country, but it was with great labour and difficulty that he went acroſs it. I directed my courſe in the mean time ſouthward in order to go to Guayaquil, penetrating through foreſts, the ground of which was ſtill ſo drowned with water, that I had often water quite up to my knees when mounted upon the talleſt horſe: it was nothing but a moraſs or a continual ſlough; the violent efforts that the mules made to diſengage themſelves expoſed the rider every moment to be daſhed againſt trees: the ſame thing happens in moſt of the places of the torrid zone, where there are woods.

This country would ſoon be fuller of tigers than of men, had not providence kindly taken care that all very miſchievous animals ſhould not multiply much; the tigers therefore are but few in number; indeed one or two of them is enough to make deſolate a whole province.

N. B. *This agrees with a fine obſervation of Herodotus, that* "Divine wiſdom and providence hath made all ſuch animals as are of a timorous heart and fit for food to be extremely teeming, but on the contrary ſuch as

" as are ſavage and malignant to produce but " few." *He gives for examples, the hare, which he ſays is the only animal of the wild kind that admits of a ſuperfetation; and the lioneſs, which he ſays produces but once in her life, and never more than one. Lib.* 3. *cap.* 108, *edit. Gronov.*

It is ſurpriſing that Ariſtotle on the contrary ſhould aſſert in his ſixth book of the hiſtory of animals, that the lioneſs produces every year in the ſpring, commonly two at a birth, but never more than ſix; and that in Syria the lioneſs produces five times in her life, at the firſt five at a birth, and every year after ſhe leſſens one. When ſhe hath completed her five times, ſhe becomes barren. Pliny hath followed Ariſtotle in this ſtrange account. But nature herſelf confutes theſe naturaliſts; for as Mr. Bouguer obſerves, and Herodotus before him, that if ſuch miſchievous animals were thus prolific, it would have been impoſſible for man to live. I cannot help obſerving likewiſe that Ariſtotle ſuperciliouſly ſneers Herodotus for the natural reaſon he aſſigns, why the lioneſs produces but once. I do not know whether any of the commentators on Ariſtotle have taken notice of it, but it is evident I think from the expreſſion, that Herodotus was the perſon levelled at. Vid. Ariſtotle's hiſt. animal, lib. vi. *cap.* xxxi.

Serpents likewiſe are common in this country, as in moſt other hot countries, and ſeveral ſorts of them are extremely dangerous.

The

The houſes in general are built with nothing but reeds, and are almoſt always raiſed upon ſtakes, ſeven or eight feet high. This precaution doth not prevent things from tainting very ſoon and putrefying, the moiſture being continually aided and rendered more active by the heat.

As ſoon as I arrived at Guayaquil, I ſet out from thence on the ſame day, and going up the river of the ſame name came the 19th of May to Caracol, which is at the foot of the Cordilleras, three days after that Mr. Godin had departed in order to paſs the mountains. He had made uſe of almoſt all the mules of the province, altho' he had left behind him at Caracol near a fifth part of our equipage, becauſe it is neceſſary on account of the difficulty of the roads to make our luggage as light as poſſible. He continued his march and arrived at Quito with the reſt of the company on the 29th of May, a year and a few days after our departure from Europe.

I could not get thither till the 10th of June; I had been obliged to wait at Caracol for want of a proper conveyance, and my health was greatly impaired by the fatigues I had undergone in coming from Rio-Jama, but principally from Puerto-Viejo to Guayaquil; I ſet out however in my turn to paſs the chain of mountains that were before me. I ſpent ſeven days in performing this journey,

altho' I reckon it no more than eight or nine leagues to croſs them; but the aſcent is extremely rugged, and interrupted by an infinite number of precipices; on the brink of which you are obliged to march; you paſs ſeveral times a little river called *Ojiva*, where ſeveral perſons every year loſe their lives; it is a torrent, whoſe rapidity is amazing, altho' its channel is pretty wide. Even when you have paſſed it for the laſt time, and are going from it, you cannot help being ſtill in a fright, the noiſe purſuing you keeps freſh the apprehenſion of dangers you have eſcaped. Sometimes you go down *a deſcent*; you meet with a deep hollow that is with difficulty paſſed, and ſpend the reſt of a day in going up only on the other ſide, where you find that you are but at a very little diſtance from the place you ſet out at in the morning.

The fatigue of the mules is ſo great, that after they have taken ſeven or eight ſteps you muſt let them reſt and take breath; thus the whole march is nothing but a ſucceſſion of ſtoppings, and movings that are very ſlow, altho' made with the greateſt toil. The rain was ſo violent and every thing ſo wet the firſt days of our journey, that we were not able to kindle a fire; we were therefore obliged to live on bad cheeſe and biſcuit. My people got me every evening the beſt lodging they could, made of the branches and leaves of trees, unleſs by chance we found an hut already

ready made by ſome other traveller. I marched *thus* ſeven days, in which I do not include the time I paſſed in a little town called Guaranda, which is imboſomed in the Cordilleras, and offers you a place of repoſe that no one fails to take advantage of. At laſt I got to the foot of a very high mountain, named Chimboraço, which is continualy covered with ſnow, and all the ground was frozen and icy. The Cordilleras being nothing but a long range of mountains, whoſe ſummits vaniſh from the ſight amidſt the clouds, there is no poſſibility of croſſing them but by narrow paſſages. That paſs by which I penetrated gave ſufficient marks of its great elevation above the level of the ſea: I was but at the foot of Chimboraço and yet found myſelf already in a region where it never rains, I ſaw nothing round me to a very great diſtance but ſnow and hoar-froſts.

I had been following exactly the track of an old troop of Spaniards, the memory of which hath been tranſmitted to us by hiſtorians. This troop was commanded by Don Pedro Alvarado, when in the firſt years of the conqueſt of Peru, and preciſely two hundred years before me, he made this ſame paſſage in order to convey a conſiderable reinforcement to Francis Pizarre. He went from Puerto-Viejo to Guayaquil, paſſing through Jipijapa, as I have done; from Guayaquil he went up to the foot of Chimboraço, and paſ-

ſed by the ſouth ſide of that mountain in order to go to Riobamba, the name of which was *then* Rivecpampa; but in paſſing over a hill, which muſt neceſſarily be the ſame as is now called the *Arenal*, ſeventy of his people, who knew nothing of Peru but the fame of its riches, and had taken no precautions, periſhed with the cold and the fatigue, and amongſt them were two or three the firſt Spaniſh women that had the courage to enter this country.

As ſoon as I was arrived at the top, I was obliged to deſcend, but was ſtruck with amazement at the novelty of the ſight; after having been ſucceſſively expoſed to the burning heat of the torrid zone and to the ſhivering cold of the frozen, I could not help fanſying myſelf of a ſudden tranſported into one of the moſt temperate climates; I thought I breathed the air of France, and ſaw her delightful fields adorned with all the beauty of the ſpring.

I diſcerned at a diſtance lands extremely well cultivated, a great number of towns and villages inhabited by Spaniards or by Indians, delightful country ſeats, and in ſhort the whole country, which is free from woods, as much peopled as ſome of our provinces. The houſes were no longer made of reeds, but ſolidly built, ſometimes of ſtone, and moſt commonly of large bricks dried in the ſhade. Each village is conſtantly adorned with a very

large

large ſquare, a part of one of its ſides is occupied by the church, from the ſquare *open* ſtreets or roads, that run in a ſtraight line and terminate at a vaſt diſtance in the country: oftentimes likewiſe the fields are cut in the ſame manner by theſe roads at right angles, which gives them the appearance of a large garden. Such is that part of the province of *Quito*, which is ſituated in the Cordilleras to the north and ſouth of that *capital*; it deſerves this title on account of its grandeur, its edifices, and the multitude of its inhabitants.

The city is near a mile in length and more than half a mile in breadth; it is the ſee of a biſhop, the place of reſidence for the preſident of a court of judicature, who is at the ſame time governor of the province; it hath a great number of religious convents, and two colleges, which are two different kinds of univerſities, the one under the direction of jeſuits, the other of dominicans. The city contains thirty or forty thouſand inhabitants, of whom more than a third are Spaniards or of Spaniſh extraction. Commodities are not extremely dear *there*; foreign manufactures alone (which it is even difficult to convey thither) bear an exceſſive price, ſuch for inſtance are our linnens, cloths, and ſilks: but the country itſelf ſupplies abundantly all the neceſſaries of life.

The richneſs of this country is owing to its being incloſed by the Cordilleras in a double range of mountains, which, like two walls, ſeparate it on the eaſt and the weſt from the reſt of America. The firſt of the two chains of mountains is at forty or forty-five leagues diſtance from the ſea, as I have already mentioned; the two ranges run parallel to each other, at ſeven or eight leagues diſtance; I mean their ſummits: ſometimes they ſpread more widely, ſometimes draw nearer to each other, but always follow pretty nearly the ſame direction, which doth not differ much from *that* of the meridian. Their great nearneſs occaſions the land that lies between, which hath five or ſix leagues of breadth, to be extremely high, and makes the two chains of mountains, which are ſo diſtinct to the inhabitants *within*, appear to thoſe that are *without* to form one ſingle maſs. Quito, and the greateſt part of its province, is ſituated thus in a long valley, which can only not be dignified with the name of mountain, becauſe it is placed between mountains that are above it, and whoſe tops are covered with ſnow. The Cordilleras are not *double* throughout the whole length; they are *ſo* for the ſpace of an hundred and ſeventy leagues, that I have travelled from the ſouth of Cuenca to the north of Popayan, and I know that they continue *double* ſtill farther to the north, although the country

country loſes by degrees, *in ſinking too low*, the good qualities which it hath about Quito.

The ſufficient breadth of this valley, and its ſituation with regard to the ſun, muſt naturally make the heat inſupportable; but on the other hand, the vaſt height of the ground and the nearneſs of the ſnow muſt temperate the heat; the two contraries blend together, and their alliance muſt produce an autumn or a continual ſpring. The thermometer of Mr. De Reaumur keeps *there* at 14 or 15 degrees; the fields are always green; you have *there* all the fruits of the torrid zone, as well as *thoſe* of Europe that have been brought thither, ſuch as apples, pears, and peaches; the trees are almoſt always in ſap; all the different ſorts of grain, and particularly wheat, thrive extremely well: they might likewiſe have wine, if Lima had not got an excluſive privilege for making it one of the branches of her commerce, whilſt Quito ſubſiſts on her own commodities, and by her manufactures of cloths and cotton ſtuffs. In ſhort, you need but chuſe a ſituation a little higher or a little lower, (for it muſt be imagined that this long valley doth not make a continued level) in order to enjoy the air and pleaſures of the moſt different climates.

The day *there* is always pretty near equal to the night; it is a perpetual equinox; and the degree of temperature in the ſame place

is likewiſe pretty near the ſame through the whole year; it is the rain alone that diſtinguiſhes the ſeaſons; the rains fall from the month of November to the month of May. Theſe rains, together with earthquakes and frequent eruptions of vulcanos, cauſe the bad qualities of the country, which balance in ſome meaſure the good ones we have mentioned.

As the inhabitants of Quito live in the higheſt region of the known world, and breathe an air that is thinner by *a third* than the reſt of mankind, we found ourſelves at firſt conſiderably incommoded by the thinneſs of the air; thoſe amongſt us that had weak lungs, perceived the difference more, and were ſubject to little hemorrhagies; which proceeded no doubt from hence, that the atmoſphere, having a leſs weight, did not aid ſufficiently by its compreſſion the veſſels in retaining the blood, which continued to have the ſame power of diſtending them. For my own part I did not obſerve that the uneaſy ſenſation from the thinneſs of the air increaſed much, when we were obliged afterwards to mount higher than Quito, perhaps becauſe I was *now* faſhioned to the country; or perhaps becauſe the cold, as one mounts higher, hinders the dilatation of the air from being ſo conſiderable as it would otherwiſe be.

Several amongſt us in aſcending up higher fainted away, and were ſubject to vomitings; but

but theſe accidents were rather the effect of fatigue, than of the difficulty of reſpiration; what proves it in an inconteſtable manner is, that we were never expoſed to them when we mounted on horſeback, or when we were once got to the top, where the air however was ſtill more ſubtile. I do not deny but the thinneſs of the air might increaſe the laſſitude, and contribute to exhauſt the ſpirits, for reſpiration became more difficult upon the leaſt action, and we found ourſelves quite out of breath by the leaſt motion; but it was not *ſo*, when we continued at reſt and inactive.

N. B. *Theſe effects that Mr. Bouguer attributes to fatigue and laſſitude, and which ceaſed when they mounted up on horſeback, ſeem rather owing to* this, *that the impetus of the blood upon the veſſels is much leſs when a man is carried by a gentle motion on horſe-back, than when he climbs up a hill by his own force. The increaſed impetus of the blood in ſuch violent motion, whilſt the air that ſhould compreſs the veſſels is become thinner, by diſtending the veſſels or villi of the ſtomach, may occaſion vomiting, or even vomiting of blood; and ſuch an affection of the ſtomach by a ſudden derivation of blood from the brain, may probably occaſion a lipothymy: which ſymptom perhaps led Mr. Bouguer into the miſtake of attributing it to fatigue, whereas ten times the fatigue would not*

not have ſuch an effect upon hardy men, that had now been long accuſtomed to fatigues.

What confirms the opinion I have given, that theſe effects were owing to the impetus of the blood being greater in walking than in riding, is the obſervation which Mr. Bouguer makes, that reſpiration was difficult upon the leaſt *action, or by the* leaſt *motion: now the* leaſt *action or motion could not occaſion laſſitude, and conſequently the ſhortneſs of breath muſt have ſome other cauſe, which I think could be no other than the increaſed momentum of the blood, whilſt the preſſure of the air, and conſequently the reſiſtance of the veſſels, was ſo greatly diminiſhed.*

The reaſon that horſes and other cattle are not in like manner affected, is probably the ſame as prevents the inhabitants of Quito from feeling any of thoſe uneaſy ſenſations, which were perceived by our Europeans, namely, *that they are naturally accuſtomed to that air.*

Quito is at the foot of thoſe mountains, named Pichincha, which belong to the weſtern chain of the Cordilleras, or *that* which is to the ſide of the South-ſea; you mount up on horſe-back to a great height, as you do up the greateſt part of the others. Several of theſe mountains reſemble one another in this, that their foot is compoſed of divers hills conſiſting of a whitiſh clay or common earth, which produces graſs, and that from the middle

middle there riſes up an high pyramid or maſs of ſtones. It is probable that *earth* covered the whole in times paſt, but that crumbling away by little and little, or tumbling down ſuddenly by ſome earthquake, it made the rock lie bare and open. It is very difficult to mount this part of Pichincha. We ſpent three weeks upon its ſummit; the cold *there* was ſo extremely ſharp, that ſome amongſt us began to feel ſcorbutic complaints, and the Indians and other domeſtics that we had taken in the country had violent gripes; they voided blood, and ſome of them were obliged to go down again from the mountain. But this indiſpoſition, when we were arrived at the top, proceeded only from the ſeverity of the cold, to which they had not been accuſtomed; and the dilatation of the air did not appear to be the cauſe, at leaſt the immediate or proximate cauſe of it. This I examined with ſo much the more care, as I had reaſon to think that the greateſt part of travellers had been deceived in it, by not diſtinguiſhing ſufficiently the different effects. Oftentimes in the evening, whilſt we were at ſupper, we had *placed* in the midſt of us an earthen pan full of fire, with ſeveral wax lights and candles burning, and the door of our tent or hut was ſhut with double leathers; but notwithſtanding all *that* the water froze in our glaſſes. We had the utmoſt difficulty to regulate a pendulum clock; we were

almoſt

almoſt continually enveloped with clouds; ſometimes the weather changed three or four times in half an hour; a tempeſt was ſucceeded by a ſerene ſky, and in a moment *after* we ſhould be ſtunned with a clap of thunder, by ſo much the louder as it was extremely near us. In ſhort, our mountain was with reſpect to ſtorms and tempeſts in the ſame ſituation as a rock in the ſea, againſt which the waves continually daſh and break. We had a thermometer brought to us towards the end of our abode *there*, but it was not till we thought the cold a little abated. This thermometer, which was one of Mr. de Reaumur's conſtruction, varied *there* much more than it had done below at Quito, or on the ſea-ſide. It often varied from the morning to the afternoon 17 degrees, altho' we kept it always in the ſhade.

The mercury in the barometer, which was on the ſea-ſhore at 28 inches 1 line, roſe *here* no higher than 15 inches 11 lines; the elaſticity of the air was exactly proportionate to its condenſation, in the ſame manner as it was on the ſea-ſhore, and hath been conſtantly obſerved in Europe.

We had frequent opportunities of obſerving how much ſome philoſophers have been deceived in thinking, that *clouds* are of a different nature from *fogs*. Oftentimes the clouds did not reach ſo high, but we ſaw them five or ſix hundred fathom below us; they

they prevented us from seeing the *earth*, whilst they darkened the *sky* to the inhabitants of Quito. At other times these clouds were less heavy, they mounted up higher, and were with respect to us a mere fog, although the observers below had still the same reason to consider them as clouds. When I have looked at them very much below us, they have always appeared to me extremely white; I cannot give a better representation of them, both with respect to the colour and figure they had to my eye in that situation, than by comparing them to heaps of cotton that should touch one another, and whose assemblage should form an undulated surface. As to the colour, the same thing happens precisely to water as to glass: it is well known that the most transparent glass becomes opake, if after reducing it to powder you hold it up to the light; but appears with the whiteness of snow, if you look at it on the side that the light falls. It is the same thing when water is reduced into very little parcels or drops, such as are those in the clouds or in fogs. The little bubbles present too great a number of minute surfaces; they appear dark when looked at from *beneath*; whereas if the spectator is placed *above*, as we were often on the top of Pichincha and other mountains, all the rays being reflected and mixed, after having suffered divers refractions, form *a white*,

white, agreeably to what we know of the properties of light.

One ſees almoſt every day on the tops of theſe mountains an extraordinary phenomenon, which muſt be however as ancient as the world, and yet it doth not appear that any one hath taken notice of it before. The firſt time we obſerved it, we were altogether on the top of a mountain leſs high than Pichincha, and which is named Pamba-marca. A cloud in which we were involved *diſſipating*, we ſaw the riſing ſun extremely ſplendid; the cloud paſſed on the other ſide, it was not thirty paces from us, and was at too ſmall a diſtance to have acquired the *whiteneſs* I have mentioned; but every one of us ſaw his ſhadow projected on it, and each could ſee none but his own, becauſe the cloud had an un-even ſurface. The little diſtance permitted us to diſtinguiſh all the parts of the ſhadow, we could diſcern the arms, the legs, the head; but what ſurprized us is, that the head was adorned with a glory, like what you ſee round the heads of ſaints in pictures, it was compoſed of three or four concentric crowns of a very lively colour, and each with the ſame varieties as a primary rain-bow, the *red* being outward. The intervals between theſe circles were equal, but the laſt circle was fainter; and at a great diſtance we ſaw a large white circle that inviroued the whole. It was a kind of

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apotheoſis to each ſpectator; and I cannot forbear mentioning again, that each one enjoyed the ſecret pleaſure of ſeeing himſelf adorned with all theſe crowns, without perceiving *thoſe* of his neighbours. I muſt obſerve however, that this phenomenon doth not appear unleſs the aqueous particles of the cloud are *frozen*, and therefore is not ſeen on drops of rain, as the rain-bow. It is probable that it might be perceived ſometimes upon ſome of our lofty towers.

Several of the mountains in Peru are ſubject to eruptions of fire, and have been formerly vulcanos. Whilſt Mr. De la Condamine and I were on one of the ſummits of Pichincha, which had been formerly a vulcano, it happened that another vulcano burſt out in the eaſtern chain of mountains, and almoſt beneath our eyes; the melting of ſnows, the torrents of waters, the horror and conſternation we were in muſt be left to the reader's imagination.

There is in all this range of mountains as far as I have travelled a conſtant *inferior* boundary beyond which the ſnow never melts; this boundary in the midſt of the torrid zone (for it is leſs high in proportion to the diſtance from the equator) I found to be 2434 fathom above the level of the ſouth ſea. The ſnow indeed falls much lower, but then it is ſubject to be melted the very ſame day; whereas

whereas above *that* it preſerves itſelf,

"*The gather'd winter of a thouſand years.*"

There muſt likewiſe be a *ſuperior* boundary, beyond which the ſnow never falls at all; but it is probable that the higheſt mountains never reach it. If there were *any* ſufficiently high to exalt their tops above all clouds, there would be that ſerenity, which Homer and Lucretius have vainly aſcribed to Olympus,

Sedeſque quietæ;
Quas neque concutiunt venti, neque nubila nimbis.
Aſpergunt, neque nix acri concreta pruinâ
Cana cadens violat; ſemperque innubilus æther
Integit, et largé diffuſo lumine ridet.

Mr. De la Condamine and I went up once above the conſtant inferior boundary of ſnow upon a mountain called Chouſſalong. Its rocky part hath the ſhape of a roof of a houſe, and its extremity towards the north being at that time almoſt intirely deſtitute of ſnow we took the advantage of it, altho' with a great deal of difficulty; when we were arrived at the top, we were ſurrounded by ice.

This mountain is 2476 fathom high, the mercury in the barometer ſtood at 15 inches 9 lines, which was a little more than 12 inches 3 lines *lower* than on the ſea-ſhore. A barometer had never been carried to ſo high

a place, and it is probable that no one had ever mounted ſo high before; for a man muſt have ſome motive for undertaking ſuch journies. The deſire of riches that actuates mankind, inſtead of leading them to the tops of ſuch lofty mountains, rather induces them to dig into the bowels of the earth, where nature hath hid the ſhining miſchief.

The mountains in the neighbourhood of Quito appear to contain but few metalline parts; altho' they have found there in times paſt, and ſtill continue to find, ſome gold ſand.

You cannot diſcern *here* any footſteps of great inundations, which have left ſuch viſible marks in every other region. It is very eaſy at Peru to obſerve the internal ſtructure of the earth to a very great depth, becauſe it is every where cut by deep trenches. Theſe trenches are frequently 200 fathom broad and between 60 and 80 deep, there are ſome above double that ſize.

N. B. *This juſtifies the account Mr. Lemery hath given of the manner in which air is admitted into the bowels of the earth for the production of earthquakes, agreeably to his ſolution. Vid. pag.* 15.

By going down theſe caverns you may ſee all the qualities of the different *ſtrata* of earth, but will diſcover no foſſil. One finds there a great deal of that black ſand, which is at-

tracted by the loadſtone; and you may diſcern in general that the *ſtrata*, whoſe colourings are very diſtinct, far from being the effect of different inundations of water, are rather the effuſions of matter vomited by vulcanos: almoſt all appears to be the work of fire. Some of theſe mountains even to a very great depth conſiſt of nothing but ſcoria, pumice ſtones, and fragments of burnt ſtones of all ſizes; and ſometimes the whole is covered by a bed of common earth, which bears graſs, and even trees.

Marks of ancient eruptions are viſible in many places, but particularly at the foot of Cotopaxi. I fanſy we ſaw the remains of that terrible eruption which all hiſtorians take notice of, that happened after the death of Atahualpa the laſt emperor, in the beginning of the year 1533. We could not without amazement behold the extraordinary marks of it, ſuch as ſtones 8 or 9 feet long and as many thick, that had been thrown more than three leagues diſtant, and ſeveral of them forming *trains*, which indicated the vulcano from whence they had been darted. The Indians conſidered this eruption as a deſtiny foretold them, and as the fatal moment, wherein it was in vain to defend themſelves againſt the invaders, that were appointed to ſubdue them.

The laſt fiery eruption of this mountain in the year 1742 happened in our ſight, as I have mentioned before; but it cauſed no other

other miſchief than what followed from the ſudden melting of the ſnow, the water roſe in ſome places more than an hundred and twenty feet, its impetuoſity carried off an infinite number of cattle; ſwept away five or ſix hundred houſes, and drowned eight or nine hundred perſons. All this water had 17 or 18 leagues to run, or rather to ravage in the Cordilleras towards the ſouth, before it could have any iſſue from thence at the foot of Tonguraga; it was no more than three hours in traverſing that extent of ground. This eruption opened a new vent on the ſide, about the middle of the height of the mountain.

As the torrid zone and the frozen zones are ſo blended, as I may ſay, at Peru, that one finds *there* the moſt contrary climates, that it is ſufficient to go a few leagues, to enter into the Cordilleras or to go out of them, in order to find countries more different one from another than you will find in travelling over all Europe; this extreme difference cannot fail to occaſion a diverſity in the cuſtoms and even in the tempers and diſpoſitions of theſe people. At the bottom they live retired in their foreſts, forming as it were little republics under the direction of their paſtor, who is a Spaniard, and their governor, aſſiſted by ſome other Indians that ſerve him as officers. They live in as great harmony as they appear to live in perfect innocence: they

are courteous and honeſt, incapable of any miſtruſt, and it never comes into their thoughts that any one can have an intention to deceive them. The doors of their houſes are always open, altho' they have cotton, gourds, little pieces of money, a kind of aloes from which they get thread, and ſome other commodities of which they often make traffick. The great heat permits them to go almoſt naked; they paint their bodies commonly red; inſtead of painting them intirely throughout, they make only ſtreaks, and draw them even on their faces. This cuſtom ſeems to have taken riſe from precaution againſt the bite of a kind of gnats, the multitude of which is extremely great in all the lower parts of the torrid zone, where the land hath not been well cultivated.

Theſe ſame Indians are *of all* trades that are neceſſary to them; they are carpenters, architects, ſhip-wrights for building ſmall veſſels, and weavers. As to any great works, ſuch as building houſes, the cuſtom is for an Indian to invite all thoſe of his neighbourhood, who work in common, and have no other pay than elegant entertainment. The houſe, however large it may be (for in ſome places three or four ſeparate families lodge under the ſame roof) by ſuch a number of hands is finiſhed in one day, and ſometimes requires no more than an hour's labour.

They

They have the advantage of joining to the fruits of the earth, which are in vaſt abundance, a great plenty of proviſions by ſhooting and fiſhing. They kill their game either with arrows, which are ſometimes the poiſoned arrows, or with balls of clay ſhot from a kind of pop-guns; as to fiſhing, it is by ſo much the more eaſy, as the rivers, having no longer that declivity which made them ſuch furious torrents in the mountains, contain fiſh in abundance *here* below.

I have had the opportunity of obſerving that thoſe, who live immediately at the foot of the Cordilleras on the weſtern ſide or towards the ſouth ſea, are almoſt as *white* as we. Theſe are not expoſed like the others to a violent and continual drying wind; on the contrary, they paſs their days in a country, where there reigns ſuch a perfect calm, that it is never interrupted by the leaſt blaſt of wind, the mountain ſheltering them from the continual eaſterly wind, which muſt paſs near a league over their heads. If you go further from the Cordilleras towards the coaſt, the wind hath a great effect upon the ſkin, and the Indians have their uſual colour, of copper. It is true that if the fleſh colour of the *former* doth not differ from ours, yet *they* are ſufficiently diſtinguiſhed from *us* by having no beard, nor hair upon their breaſts, nor in any other part of the body; and what characterizes them ſtill more is their long head

of hair; they have always big, black, lank, and very ſtrong hairs.

The condition of the Indians that live aloft in the Cordilleras is not the ſame, but they are intirely a different ſort of men. They have as many *bad* qualities as the others have *good*. They are all extremely idle and ſtupid; they will paſs whole days in the ſame place without ſtirring, or ſaying a word.

It muſt be owned that when one compares the Indians both without and within the Cordilleras with the *paintings* that ſome hiſtorians have given of them, one can ſcarce believe one's own eyes; all that *they* have related of their talents, of the different conſtitutions of government, of their laws, and policy, appears a mere dream, and would be ſuſpected if there did not remain ſeveral monuments, which prove invincibly that we muſt not judge of the ancient ſtate of theſe people by what we ſee at preſent.

One cannot conceive how they could raiſe the walls of the temple of the ſun, the remains of which are ſtill ſeen at Cuſco; theſe walls are formed of ſtones 15 or 16 feet in diameter, and which, tho' rough and irregular, do all ſo exactly fit one the other that they leave no *void* between them. We ſaw the ruins of ſeveral of thoſe edifices, which they called *tambos*, and made uſe of as magazines; *there* the Incas lodged when they travelled. The gates of the *tambos* are not wide

but

but extremely lofty, becauſe the ſovereign never went out but he was carried in a kind of litter, ſupported on the ſhoulders of the principal lords of his court. The walls are often of a ſort of granate. All theſe edifices were ſituated along the magnificent road that led into the Cordilleras from Cuſco to Quito, and was near 400 leagues long; we could often trace the remaining footſteps of this road. I ſhall not deſcribe the different intrenchments made with art upon the ſummit of ſeveral mountains, which muſt be attributed to the natives of the country when they dearly ſold their liberty to the other Indians, that came from Cuſco under the conduct of Huayna Capac, before he was yet emperor, and a little before the entrance of the Spaniards. It is probable that the tombs of a ſurpriſing grandeur and form, which we found in a place named Cocheſqui, were raiſed about the ſame time. They are mounds of earth, ſome of which have 40 feet in height upon 420 in length and 240 in breadth, with flights of ſteps extremely long that lead to the top by a very eaſy aſcent. There are ſeven or eight of *this* form, and more than an hundred of a different *one*.

Hiſtorians make mention of a palace that the Incas had in the ſame place, but no mark of it remains; whereas the tombs, which no hiſtorian hath mentioned, are ſtill ſubſiſting.

Almoſt all the ancient works of the Peruvians have been ſubject to the ſame fate,

— *Ipſæ periêre ruinæ.*

The more they have attracted attention, the more they have been deſtroyed.

All that I can add is, that it is impoſſible to behold ſuch monuments as are ſtill remaining without being diſpoſed to think advantageouſly of thoſe, who had the boldneſs to undertake and the reſolution to finiſh them.

Memoirs 1744, *pag.* 252.

It is needleſs perhaps to remark to the reader, but I take a pleaſure in repeating it, that all the obſervations at Peru, as well as at the polar circle, confirmed the Newtonian theory.

Natural curioſities obſerved in the courſe of the river of the Amazons, by Mr. de la Condamine.

In order to multiply opportunities of making remarks in that part of the world whither we had been ſent to determine the figure of the earth, we agreed, Mr. Godin, Mr. Bouguer, and I, to return back by different roads. If curioſity alone had determined my choice, I ſhould not have heſitated to take the *road* of Mexico or of Paragua; but I prefered *another*, which was much more unknown, and that I was ſure no one would envy me; it was *that* of the river of the Amazons, which paſſes for the greateſt river of the world, and which croſſes the whole continent of ſouth America, from weſt to eaſt. I knew that this enterpriſe had its difficulties; but after having maturely reflected on them, I judged

that none of the obſtacles, which had been alledged in order to divert me from my project, were unſurmountable with a little reſolution. The leſs travellers have had opportunities of penetrating into thoſe vaſt regions unknown to the reſt of the world, the more I hoped to render my voyage uſeful, by taking a map of the courſe of the river as I went down it, and by collecting obſervations in every kind, which I ſhould have the opportunity of making in a country ſo little frequented.

I muſt obſerve that the extremely faulty map of the courſe of the river of the Amazons, made by Sanſon from relations merely hiſtorical, hath been copied by all geographers *ſince*, for want of new memorials; and we never had a *better* till the year 1717 in the 12th tome of *Lettres edif. et cur.* copied from a draught of father Samuel Fritz a German jeſuit, miſſionary for the crown of Spain on the borders of this river: but he had not conveniencies for giving an exact map; and therefore I have given another, in which I have marked the courſe of the river according to father Fritz, that the reader may diſcern the difference between us. I am ſenſible however that my own is very far from perfection, which in drawing the courſe of a river is very difficult to be attained, eſpecially on ſo narrow a ſcale.

It it commonly thought that the firſt European who diſcovered this river, which went by

by the name *Maragnon*, was Francis d'Orellana in the year 1540. The report he made of having met with ſome armed women in going down the river, of whom an Indian captain bad him beware, occaſioned the name of *river of the Amazons* to be given it in the patent granted in Spain to Orellana for the conqueſt of this country.

The Maragnon or river of the Amazons, after iſſuing from the lake *Lauri-cocha*, where it takes its riſe at about 11 degrees of ſouth latitude, runs northward as far as Jaen at 6 degrees of ſouth latitude; from thence it takes its courſe eaſtward, almoſt parallel to the equinoctical line quite to Cape de Nord, where it enters into the ocean juſt beneath the equator itſelf, after having run from Jaen, where it begins to be navigable, 30 degrees in longitude or 750 common leagues, which, *allowing* for the windings of its courſe, muſt be reckoned 1000 or 1100 leagues, *that is* 3000 Engliſh miles. It receives on its north and ſouth ſide a prodigious number of rivers; ſeveral of which have a courſe of five or ſix hundred leagues, and ſome of them are not inferior to the Danube and the Nile. The borders of the Maragnon were peopled about a century ago by a great number of nations, which have retired further within land in order to avoid the Europeans. One finds *there* at preſent only a few little towns, conſiſting of the natives of the country, that have been lately

lately drawn out of their woods, either *they* or their fathers, by Spaniſh miſſionaries on the upper part of the river, or by Portugueſe miſſionaries who are ſettled in the lower part.

I ſet out from Tarqui, which lies five leagues to the ſouth of Cuenca, on the 11th of May 1743. In my journey to Lima in 1737, I had taken the uſual road from Cuenca to Loxa: this time I turned out of that road to go to Saruma, in order to fix that place upon my map. I ran ſome riſk in fording the great river *de los Jubones*, which was very much ſwoln at that time, and is always extremely rapid; but by this danger I eſcaped *another* much greater, of being aſſaſſinated, for people had been hired to way-lay me on the other road, to prevent my carrying complaints to the council in Spain againſt the iniquity of a ſentence of the *royal audience* at Quito.

From a mountain, over which I paſſed in my road from Cuenca to Saruma, you ſee Tumbez, a port of the South-ſea, where the Spaniards firſt landed on the other ſide the line, when they conquered Peru.

I found the height of the mercury in the barometer at Saruma 24 inches 2 lines; it is well known that the barometer doth not vary in the torrid zone as in our climates; I am perfectly aſſured from obſervations made at Quito during the compaſs of whole years, that its greateſt difference ſcarce ever exceeds

a line and half. Mr. Godin was the firſt who obſerved that theſe variations, which are about a line in 24 hours, have pretty regular ſtated periods at the ſame hours of the day.

I found by frequent experience on the coaſts of the South-ſea, that the mercury at a medium, on a level with the ſea, was near upon 28 inches; from whence I may conclude, agreeably to Mr. Bouguer's table, * founded on an hypotheſis that correſponds the beſt with all our obſervations of the barometer, taken at divers elevations which were determined geometrically, that Saruma is ſituated about 700 fathom high, which is not half the height of the ground on which Quito ſtands.

In my road I met with ſeveral rivers that I was obliged to croſs upon bridges of cords made of the rinds of trees, or of a ſort of oſiers. Theſe oſiers, twined in the manner of net-work, form from one ſhore to the other a gallery ſuſpended in the air by two great cables made of the ſame materials, the extremities of which on each ſide are faſtened to branches of trees. The whole preſents the ſame ſight as a fiſhing-net or an Indian *hamac*, ſtretched from one ſide of the river to the other. As the maſhes of this net-work are very large, and the foot would be in danger of ſlipping through, they take care to ſtrew ſome reeds at the bottom, which ſerve

* Vid. eſſay d'optique ſur la gradation de la lumiére, p. 153.

ſerve for a floor. The reader will eaſily conceive that the mere weight of this kind of baſket machine, and much more the weight of a man paſſing over, muſt cauſe it to make a prodigious bending; and if it be conſidered that the paſſenger, when he is in the midſt of his courſe, eſpecially if there be a wind, is expoſed to vaſt ſwingings from ſide to ſide, I need not mention that a bridge of this ſort, ſometimes more than 90 feet long, muſt at firſt ſight be extremely frightful: yet the Indians, who are far from being naturally couragious, paſs over it *running*, though loaded with all the baggage and pack-ſaddles of the mules, that they make ſwim acroſs the river, and laughed to ſee us heſitate in venturing. But *this* is not the moſt ſingular nor the moſt dangerous ſort of bridge that is made uſe of in this country.

I was obliged to tarry ſome days at Loxa, which is ſituated 4 degrees beyond the equinoctial line, about an hundred leagues to the ſouth of Quito, and one degree more weſterly. The barometer ſtood *there* at 22 inches 1 line, from whence I conclude that Loxa is about 1100 fathom above the level of the ſea, and 400 fathom lower than Quito; a difference that produces a very ſenſible alteration in the climate. At Quito the air is always temperate, at Loxa the heat is ſometimes troubleſome: from Cuenca, the ground continually ſinking, you loſe out of ſight,

ſight, by little and little, thoſe dry uninhabitable ſummits that you ſee ſo frequently in the Cordilleras; and the mountains in the neighbourhood of Loxa, covered with woods and verdure, are no more than hills in compariſon of thoſe about Quito.

The third of June I ſpent the whole day on one of theſe mountains: with the aſſiſtance of two Indians of the neighbourhood that I had taken for my guide, I could not in the whole day collect more than eight or nine young plants of *Quinquina* (the bark) that were fit to be tranſported. I had them put with earth taken from the ſpot in a box of a ſufficient ſize, and carried on the ſhoulders of an Indian that walked in my ſight, I uſed the ſame precaution quite to the place where I embarked. I flattered myſelf that with all this care and attention I ſhould preſerve at leaſt one plant, and propoſed to leave it in truſt at Cayenne, if it was not in condition to be tranſported immediately into France to the royal garden.

From Loxa, or rather from Caxanuma to Jaen, you go down the vale, where Chinchipé runs, and keep along at ſome diſtance from the river, which in its ſhort paſſage receives ſeveral other conſiderable ſtreams. In the road I went, leaving the river to my *right*, I croſſed five or ſix of them that run into it on the eaſtern ſide; ſome I forded, others I paſſed on oſier bridges, or on floats

which

which are made *on the ſpot* of a very light timber, that nature hath amply provided this whole country with.

It is impoſſible to convey a complete idea of the difficulties in this journey, and of the inconveniences to which one is expoſed. Theſe rivers that run acroſs your road, are ſeparated from each other by eminences which would be called mountains every where elſe: ſo that you muſt continually be going up or down, ſometimes by a kind of ladder-ſteps cut naturally in the rock, and creep up ſide-long the hollows which the torrents have made: afterwards you muſt deſcend by a path with a ſteep declivity, upon a ſlippery ſoil, where the mules are obliged to ſquat on their buttocks, and holding their fore-legs ſtiff to ſlide down the precipice. At other times you have not precipices bordering the rivers, but are obliged to make your way through thick woods, where you can ſcarce ſee day-light: you can find no other road than a miry path-way, where your mules ſink every ſtep above their knees. In this ſlow and dangerous way of travelling there is another circumſtance enough to put you out of all patience, which is that it rains in this diſtrict five or ſix hours at leaſt every day for ten or eleven months, and ſometimes the whole year. I travelled *thus* fifteen days, eight or ten hours each day, and got no further than forty leagues.

I ſpent ſome days at Jaen, where I obſerved 5 degrees 25 minutes of ſouth latitude, and I judged it about half a degree to the eaſt of Loxa. I ſet out from Jaen the 23d of June; I kept along the north ſide of the Maragnon or river of the Amazons for two days, and judge that I did not travel more ground than ſix leagues: the beaſts on which we were mounted and the ſumpter cattle could only march ſtep by ſtep on the ſide of a ſteep hill, often in a narrow and ſlippery path, from whence the ſight of the river and the depth to its channel make your head ſwim, whilſt your ears are ſtunned with its noiſe.

In this journey I croſſed ſeveral torrents that without doubt waſh very rich mines of gold, ſince they roll and depoſit on the borders a ſand mixed with grains and particles of that metal. After the great rains a man may collect a dram or two of it in a day: yet the neighbouring Indians do not go out to look for it, till they are conſtrained to pay their tax or capitation; and even then they do not load themſelves with more than the quantity which is neceſſary to ſatisfy the demand. The ſurpluſage would only be a troubleſome weight, and they would ſooner trample under foot all the gold in the world than give themſelves the pains of picking it up and ſeparating it.

In

In all this diſtrict, the two ſides of the river are covered with *wild* cocoa nuts, that are not inferior to the *cultivated*. The example of the Spaniards hath not taught theſe Indians to make uſe of them, and the badneſs of the roads preventing all exportation, hinders any uſeful commerce being made of theſe fruits.

The next day in the evening after my departure from Jaen, I croſſed the Maragnon on a float, and lay on the oppoſite ſhore. The third day in the morning, in order to eaſe my mules, I made uſe of the ſame float to go down the river to the place where the road that leads to the *embarcadero* (or place of embarking) runs wide of the river. The fourth day of my departure from Jaen, and the laſt of my journey by land, I was tranſported with the thoughts of taking a farewell for ever of mules, mule-drivers, and roads of Peru, which had exerciſed my patience for eight years; but there yet remained to paſs two and twenty times a torrent that throws itſelf into the little river of Chuchunga, where I was going to embark; theſe torrents were made by the laſt ſteps of the Cordilleras, that remained for me to deſcend; as the waters were high, the fords were become deeper than uſual at each *paſſage*. At the *ſixth* I had water quite up to the pommel of my ſaddle, and in all the *ſucceeding* my mule ſwam; at one of *them*, one of my

mules was carried away by the violence of the torrent, with his burden; two Indians threw themſelves into the water, and ſwimming excellently well recovered it: a canow, that the *cacique* of Chuchunga ſent to meet me, luckily ſaved me the two or three laſt paſſages, which were the moſt difficult; but the mules impatient to get to their accuſtomed reſting place, threw themſelves *in*, loaded as they were, and ſwam acroſs: my inſtruments, my books, my journals, my papers, my maps, and deſigns were all wetted; which was the fourth accident of that kind which had happened to me ſince I had travelled in the mountains. It may truly be ſaid, that my ſhipwrecks did not ceaſe 'till I got on ſhipboard.

I found at Chuchunga an hamlet of ten Indian families, governed by their *cacique*: the Indians at Chuchunga had only very ſmall *canows*, which are the moſt proper for their uſe; and *that* which I had ſent to get at Sant-Jago by an expreſs, could not arrive under a fortnight; I prevailed on the cacique to get me a float made by his people; the time neceſſary for preparing the *balſe* (for *ſo* they call a float, as well as the timber of which it is made) gave me an opportunity of drying my papers, and my books leaf by leaf, a precaution as neceſſary as it was tireſome: the ſun did not ſhine out 'till about noon, which was ſufficient to take its meridian altitude.

titude. I found myſelf at 5 degrees, 21 minutes of ſouth latitude, and I learnt from the barometer, which was between 15 and 16 lines lower than on the ſea-ſhore, that there are at between 220 and 230 fathoms above the level of the ſea, rivers navigable in a continued and uninterrupted courſe; for I never travelled by land after my departure from Chuchunga. Perhaps *this* is not the only river, of which it may be ſaid, experience alone can decide that point; it is certain the opportunity cannot often preſent itſelf of making the obſervation on a river of ſuch an elevation, and at three thouſand miles diſtance from its mouth.

I had *now* been eight days in the hamlet of Chuchunga, and they had ſwiftly paſſed away; I had neither robbers nor inquiſitive perſons to fear; I was indeed in the midſt of *ſavages*, but *that* only gave a reliſh to this kind of life by its contraſt to the buſy, buſtling, envious crouds of *men*; after ſeveral years paſt in continual motion and agitation, I now enjoyed for the *firſt time* a ſweet tranquillity: the remembrance of my fatigues and dangers appeared to me as a dream; the ſilence that hovered over this ſolitude made it the more pleaſing to me, and I ſeemed to breathe a purer air; the heat of the climate was tempered by the coolneſs of waters that had juſt iſſued from their ſpring, and by the thickneſs of woods that over-hung the

ſtreams; a prodigious number of uncommon plants and flowers unknown attracted my ſight, and continually amuſed with their novelty and variety. In the intervals of my labour in drying my cloaths and papers, I partook of the innocent pleaſures of the Indians; I bathed with them, and was charmed with their dexterity in ſhooting and fiſhing; they always brought me the choiceſt of their fiſh and game; I was treated like a prince by the cacique himſelf; the moſt delicious perfumes gave me *light*, as Circe is deſcribed in Virgil,

Urit odoratam nocturna in lumina cedrum,

and I trod on ſands of gold.—Word was brought that the float was ready, and, as if I had been touched by Circe's wand, the viſionary ſcene was fled.

On the 4th of July in the afternoon I embarked on board a little canow of two oars, preceded by the float loaded with my equipage, and eſcorted by all the Indians of the hamlet; they were in water up to their middles, in order to conduct my veſſel with their hands in dangerous paſſes, and to hold it back amidſt rocks, and in little falls of water, againſt the violence of the current. The next day in the morning, after many windings, I entered into a little river called *Imaça*, and from thence opened into the Maragnon or river of the Amazons, at about 4 *leagues* northward

northward from the place where I had embarked; it is *there*, properly ſpeaking, that the true bed of that river begins to be navigable, without any *fall* diſturbing its courſe. It was neceſſary to enlarge and ſtrengthen the float, which had been proportioned to the bed of the little river I had deſcended. We ſtopped for this purpoſe on a flat ſhore of ſand called *Chapuroma*; in the night the river increaſed ten feet, and it was neceſſary to convey on board the float, with the utmoſt expedition, a kind of arbour that ſerved me for a ſhelter: the Indians build theſe ſorts of lodging with admirable art and quickneſs. I was detained in this place three days, and employed them in meaſuring geometrically the breadth of the river, which I found to be 810 feet, although diminiſhed about 100 feet; ſeveral rivers that it receives above Jaen are broader, which made me imagine that it muſt be of a great depth; with a line of 28 fathom I could not ſound its depth above a third of its breadth; in the midſt of the channel, where the ſwiftneſs of a canow abandoned to the current was at the rate of ſeven feet and an half in a *ſecond*, I could not make any ſounding. The barometer, higher than at the port by about 5 lines, ſhewed me that the level of the water was ſunk about 70 fathom from Chuchunga, in which paſſage I had employed no more than eight hours; I obſerved

at the ſame time the latitude to be 5 degrees 1 minute ſouth.

On the 12th of July I paſſed the famous canal of Pongo; it begins a ſmall half league below St. Yago, and from 1500 feet *at leaſt* juſt below the union of the two rivers, it contracts itſelf to 150 feet in its narroweſt part. I obſerved by my watch 57 minutes from the entrance of the ſtreight to my arrival at Borja, though it is commonly ſaid that the paſſage is performed from St. Yago to Borja in a quarter of an hour; they reckon it likewiſe *three* leagues, but I found it to be ſcarcely *two*.

There is in the middle of the Pongo, and in the narroweſt part of it, a rock extremely high when the waters are low; but it was more than a fathom under water when I paſſed; it cauſed however an extraordinary eddy in the water, which whirled *about* my float: In the *turnings* the float ſtruck two or three times againſt the rocks, and would have frightened me, had I not been warned of it before. A canow (which can never paſs *here* but when the waters are low) would have been ſplit into a thouſand ſhivers; but the pieces of a float not being nailed or joined, the flexibility of the oſiers, that tye them together, hath the effect of a ſpring that deadens the blow; the ſteepneſs of the rocks on each ſide, which ſeem almoſt to join at the top, and the trees, that jutt out and form a kind

kind of arch *above*, throw ſuch a gloom over the whole canal, as ſtrikes one with its ſingular and pleaſing appearance; I had ſcarce time enough to enjoy this ſcene, before the view of Borja opened to my ſight; and as ſoon as I arrived thither, I thought myſelf in a new world, ſeparated from all commerce with mankind, on a ſea of freſh water, in the midſt of a labyrinth of lakes, rivers, and canals, diffuſing themſelves through an immenſe foreſt, which they alone render acceſſible. I ſaw new plants, new animals, new men; my ſight that had been tired for ſeven years with gazing up to mountains, was now refreſhed with ranging through the wide expanſe of heaven, where nothing bounded the view on any ſide but the hills and woods above Pongo; the eye delighted to ſkim along the ſurface of the water, or dwelt with pleaſure on the level verdure of the foreſt.

Below Borja, and for 4 or 500 leagues down in the courſe of the river, a flint ſtone is as great a rarity as a diamond. The ſavages of thoſe countries know not what a *ſtone* is, have not ſo much as an idea of it. It is a very diverting ſight to ſee ſome of them, when they come to Borja, and meet with ſome ſtones for the firſt time, ſhew their admiration by ſigns, eagerly picking them up, and loading themſelves with them, as *precious* commodities.

Although there is great diverſity in the various nations that inhabit this vaſt tract of country, with reſpect to their complexion (which probably is owing to the different temperatures of climates) with reſpect to cuſtoms, manners, *&c.* ariſing chiefly from mixtures of Portugueſe and Spaniſh; yet the general fund of character is through all the ſame; and I am ſorry to ſay that it is ſtupidity, or at the beſt a puerility, which makes their fundamental character; they are either ſenſual or childiſh, voracious gluttons, and ſober only through neceſſity, cowards to an exceſs, unleſs inſpirited by liquor; indolent, and inſenſible of any motive of glory, honour, or gratitude; they expreſs their joy by jumping and immoderate laughing, and grow old without ever quitting childhood; one cannot without a mortifying ſentiment perceive in *them*, how little *human* nature, deſtitute of education and ſociety, differs from the *brute*.

All the languages of South-America, as far as I have been able to get any knowledge of them, are very *ſcanty*; yet ſeveral of them have an energy, and are ſuſceptible of elegance, in particular the ancient language of Peru; but all of them want terms to expreſs abſtract, and general ideas; which is an evident proof of the little improvement of *the underſtanding* amongſt them: *time*, *duration*, *ſpace*, *being*, *ſubſtance*, *matter*, *body*, and ma-

ny other ſuch words, have nothing equivalent in their languages; not only names of a metaphyſical, but likewiſe *thoſe* of a moral nature cannot be rendered in their tongue but imperfectly, and by a circumlocution; they have no words that correſpond exactly to thoſe of *virtue*, *juſtice*, *liberty*, *gratitude*, and *ingratitude*. What I have ſaid will appear inconſiſtent with what Garcilaſſo reports of the policy, induſtry, arts, government, and genius of the ancient Peruvians; if the love of his country did not delude him, it muſt be acknowledged that theſe people have greatly degenerated from their anceſtors. It is ſaid that ſome caciques of the upper Peru deſerve to be excepted from the judgment I have given in general of theſe Indians; but I appeal to *thoſe* who have had the opportunity to frequent them.

I have made a vocabulary of the words that are moſt in uſe in the divers languages of America; the compariſon of theſe words with thoſe which have the ſame ſignification in other languages of the inland country, may not only ſerve to prove the divers tranſmigrations of theſe people from one extremity to another of this vaſt continent; but likewiſe the comparing them, where it is poſſible, with the various languages of Africa, Europe, and the Eaſt-Indies, is, perhaps, the only means of diſcovering the origin of the Americans: a conformity of language well

well averred would without doubt decide the queſtion; the word *abba*, *baba*, or *papa*, and that of *mama*, which from the || antient eaſtern languages ſeem to have paſſed with very little alterations into the greateſt part of the languages of Europe, are common to a great number of nations in America, whoſe language is in other reſpects extremely different. If *theſe* words are conſidered as the firſt ſounds that children are able to articulate, and conſequently as thoſe which muſt naturally be adopted by parents in every country to make them ſerve for ſigns of the ideas of *father* and *mother*; yet ſtill the queſtion will remain, how comes it to paſs that in all the languages of America, where theſe words are to be found, their ſignification hath been preſerved without varying; by what chance in the Omague language, for example, in the center of the continent, hath it never happened that *papa* ſhould ſignify mother, and *mama* father, but that their ſignification *there* hath been conſtantly fixed, as in the languages of the Eaſt and of Europe?

As to the queſtion Mr. De la Condamine hath propoſed, I think the true ſolution of it is this; the vowel a *is the moſt eaſy of pronunciation, and you may obſerve infants mimick the ſound long before they are able to articulate; by degrees they join ſome conſonant to it; now the letter* m *is the leaſt difficult of all, in ſhort, it*

|| Vid. Homer, Iliad vth, verſe 408.

it requires only a gentle ſtriking of the two lips, with a free paſſage of air through the noſe; as ma-ma therefore will be the moſt eaſy, and by conſequence the ſooneſt pronounced, it will naturally in all languages be applied to the mother, with whom the child is firſt acquainted.

I obſerved at Borja the latitude to be 4 degrees 28 minutes ſouth, and the variation of the compaſs near 9 degrees towards the north-eaſt.

I ſet out from thence the 14th of July with father Magnim, who was willing to accompany me as far as Laguna; we left the 15th to the north of us the mouth of the Morona, which deſcends from the Vulcano of Sangay, whoſe aſhes fly ſometimes acroſs the provinces of Macas and Riobamba beyond Guayaquil.

The 19th we arrived at Laguna, and I obſerved the latitude to be 5 degrees 14 minutes.

I ſet out with two canows from Laguna the 23d, accompanied by Mr. Maldonado. On the 25th, we ſtopped at a new religious eſtabliſhment of Savages called *Yameos*, that have been very lately drawn out of the woods; their language is of an inexpreſſible difficulty, and their manner of pronouncing it is ſtill more extraordinary than the language; they ſpeak without ſounding almoſt any vowel; they have words which we cannot write even imperfectly without employing nine or ten

ten ſyllables, and yet theſe words pronounced by them ſeem to have no more than three or four; *poetarrarorincouroac* ſignifies in their tongue the number *three*; it is happy for thoſe who have any buſineſs with them, that their arithmetic doth not go any farther; however incredible it may appear, this is not the only Indian nation that is in this condition; the Brazilian language, which is ſpoken by a people leſs ſavage, is under the ſame want; when they have paſſed the number *three*, they have nothing but a vague term which means a multitude, and, in order to count *four*, are obliged to borrow the aid of the Portugueſe language.

The Yameos are very ſkilful in making long *ſarbacanes* (pop-guns) which is the uſual inſtrument of the Indians for killing game; they adjuſt to it little arrows that are made of the palm-tree wood, and, inſtead of a feather, are fledged with a little roll of cotton, which exactly fills the hollow of the tube; they dart the arrow with their breath to 30 or 40 paces, and ſcarce ever fail to hit the mark.

I have often ſeen a canow ſtop, an Indian land, go into the wood, bring down a monkey or a bird perched on the top of a tree, carry it away, take up his oar again, and *all* performed in leſs than two minutes. An inſtrument as ſimple as theſe *ſarbacanes* ſupplies amongſt all theſe nations the want of fire-arms;

arms; they dip the point of theſe little arrows, as well as *thoſe* for their bows, in ſo active a poiſon, that when it is freſh it kills an animal in leſs than a minute, if it but touches the blood. Although we had fowling-pieces we ſeldom fed on any game but what was killed by theſe arrows, and often found the point of the arrow under our teeth; but the venom occaſions no miſchief when taken by the mouth, as Lucan hath obſerved with reſpect to the poiſons of Africa,

Ne dubita, miles, tutos haurire liquores:
Noxia ſerpentum eſt admiſto ſanguine peſtis:
Morſu virus habent, et fatum dente minantur:
Pocula morte carent.—

We ſaw at Parà ſeveral Portugueſe that had ſeen the fatal effects of theſe arrows on their comrades, *in an inſtant*, and from a wound no bigger than the prick of a pin; ſalt, but more certainly ſugar, is commonly thought to be an antidote to this poiſon.

During my continuance at Cayenne, I had the curioſity to try if the venom of the poiſoned arrows, which I had kept more than a year, had ſtill preſerved its activity, and at the ſame time whether ſugar was in reality a counterpoiſon ſo efficacious as I had been aſſured.

A fowl ſlightly wounded by blowing from a ſarbacane a little arrow, whoſe point had been

been ſmeared above a year before with the venom, lived no longer than 7 minutes and half; another wounded in the pinion with one of theſe ſame arrows, but which had been freſhly dipped in the venom diluted with water, and was immediately drawn out again from the wound, appeared drowſy in a minute *after*; convulſions ſoon followed, and although we made it ſwallow ſugar, the fowl expired; a third, pricked in the ſame place with the ſame arrow freſh dipped in the poiſon, having had the ſame remedy immediately applied, gave no ſign of any diſorder.

I repeated the ſame experiments at Leyden, in the preſence of Meſſ. Muſſenbroek, Albinus, and Vanſwieten, the 23d of January 1745; the poiſon, whoſe violence muſt have been very much weakened by the length of time, and the cold weather, had not its effect under five or ſix minutes; but the ſugar was given without ſucceſs; only the fowl that took it appeared to live a little longer than the other; the experiment was not repeated.

This poiſon is an extract made by diſtillation from the juices of ſeveral ſorts of plants, and particularly certain creepers (called lianes;) they ſay that there are more than thirty ſorts of herbs or roots which enter into the compoſition of the poiſon made by the *Ticunas*; it was *this* I made my experiments with, and it is the moſt in eſteem of all the ſorts

known along the river of the Amazons. The Indians compoſe it always in the ſame manner, and follow the proceſs they have received from their anceſtors as ſcrupulouſly as our pharmacopæias proceed in the ſolemn compoſition of the *theriaca*; tho' probably that great multiplicity of ingredients is no more neceſſary in the Indian poiſon, than in the European *antidote*.

The reader undoubtedly will be ſurprized at what I am going to mention, that amongſt theſe people, who have at their diſpoſal ſo certain and ſo ſpeedy a means of ſatisfying their hatred, jealouſy, and revenge, ſo ſubtile a poiſon ſhould be fatal only to monkeys, apes, and birds: eſpecially when it is conſidered that theſe people, ſo harmleſs, are at the ſame time ſavages, and moſt commonly deſtitute of any notion of religion.

I cannot forbear obſerving that the moſt ſavage and the moſt ſtupid people have been the moſt ingenious in the arts of poiſoning, and have contrived ſuch methods of giving a ſpeedy or at other times a ſlow but certain death, as have greatly puzzled the philoſophers of civiliſed countries to diſcover. But the reaſon ſeems to be this, *If it be an animal poiſon made uſe of (as Pliny reports of the Scythians that they poiſoned their arrows with the ſanies of vipers) that the animals are leſs vigorous with their poiſons in the colder and more civiliſed countries; or if the poiſon be derived from plants, that*

that thoſe plants are either not found in theſe countries, or greatly degenerate by the ſoil and climate. I beg leave to produce an inſtance, which will at the ſame time give light and authority to a paſſage in the Cyri Expedit. Lib. iv.

Xenophon mentions in the famous retreat of the ten thouſand " that the ſoldiers ſucked " ſome honey-combs in a place near Trebi- " zonde where there was a great number of " bee-hives, that all who ſucked them be- " came intoxicated, vomited, and purged; " not one was able to ſtand upon his legs, " thoſe, who had taken but little, were like " men drunk, but thoſe, who had taken a " good deal, were like men mad, and ſome " lay like men dead: the next day about the " ſame hour they recovered their ſenſes, but " it was three or four days before *they* were " entirely reſtored, as if they had taken a " poiſon." *This fact cannot be a romance from ſo grave a writer, who was preſent and for a conſiderable time had the principal command. Mr. Tournefort in his travels through this country was particularly attentive to this account of Xenophon, and obſerves that the* chamærhododendros pontica, maxima, meſpili folio, flore luteo, *which grows commonly in the neighbourhood of Trebizonde, hath theſe effects, and that even its ſmell affects the head; he judges therefore that the honey had been extracted by the bees from the chamærhododendros,*

and

and adds, that father Lamberti a miſſionary obſerves that the honey which bees gather from a certain ſhrub of Colchis or Mingrelia is dangerous, and cauſes vomiting; from the deſcription Mr. Lamberti hath given of the ſhrub, Mr. Tournefort pronounces it to be the chamærhododendros, meſpili folio; its ſmell very much reſembles the honey-ſuckle's, but is much ſtronger. Vid. memoirs 1704, *pag.* 351.

It is but within a few centuries that the lauro-ceraſus was imported into Europe, from Trebizonde, and but within a few years that it hath been found to afford ſo ſudden a poiſon; I know ſome other vegetable extracts that give as ſpeedy a death, but as they are not commonly known, I ſhall not divulge them. But to return to my ſubject, as theſe plants grow only in the hot countries or at leaſt degenerate frequently by being tranſplanted, it is no wonder that the inhabitants of thoſe countries, altho' ſavages, ſhould be the firſt diſcoverers of ſuch poiſons, and the moſt artful in applying them.

The next day, 26th, I ſounded the river in a place free from any iſland, where its bed, that a little *above* was 4200 feet wide, had contracted itſelf to leſs than 900; I found no bottom at 80 fathom.

A little further on the ſouth ſide of the river we met with the mouth of the *Ucayalé*, one of the greateſt rivers that run into the Maragnon. Below the *Ucayalé* the breadth

of the Maragnon enlarges greatly, and the number of its iſlands increaſes.

The 27th in the morning we landed at the miſſion of St. Joachim, compoſed of ſeveral Indian nations, and particularly of the *Omaguas*, formerly a very powerful people. A nation that bears the ſame name *Omaguas*, and which dwells near the ſource of one of thoſe rivers that riſe in the new kingdom of Granada, and run into the Maragnon; the uſe of clothes which we found eſtabliſhed amongſt the Omaguas *alone* of all the nations that people the borders of the Amazon; ſome remains of the ceremony of baptiſm, and ſome diſfigured traditions, are an evidence of the tranſmigration of this people. Father Samuel Fritz had converted them to the chriſtian religion at the end of the laſt century, and there were reckoned *then* in their country thirty villages marked with their names on the map of that father. All the inhabitants of theſe villages, frighted by the incurſions of ſome robbers, that came to get ſlaves amongſt them, diſperſed into the woods, or into the Spaniſh and Portugueſe miſſions.

The name of *Omaguas* in the language of Peru, as well as that of *Cambevas*, which the Portugueſe of Para give them in the language of Brazile, ſignifies *flat-head*. The reaſon of this name is, that theſe people have an odd cuſtom of preſſing between two boards

boards the upper part of the head of children as ſoon as they are born, and procuring them the ſtrange figure that reſults from thence, in order to make them reſemble, as they ſay, the full moon.

The Omaguas make great uſe of two ſorts of plants, the one is called by the Spaniards *floripondio*, the flower of which hath the figure of a bell inverted; the other in the Omagua language is named *curupa*; they are both purgative. Theſe people procure themſelves by means of theſe plants a drunkenneſs, that laſts for 24 hours; during which they have very ſtrange viſions. They take likewiſe the *curupa* in powder as we take ſnuff, but with greater ceremonies: they make uſe of a reed terminated like a fork, or in the ſhape of the letter Y; a branch is inſerted into each noſtril: this operation followed by a violent inſpiration, cauſes them to make wry faces that are very ridiculous in the eyes of an European, who cannot forbear referring every thing to his own cuſtoms.

The language of the Omaguas is as ſoft and eaſy to pronounce, and even to learn, as *that* of the Yameos is rough and difficult: it hath not the leaſt conformity with the language of Peru nor of Brazil, the former of which is ſpoken *above* and the latter *below* the country of the Omaguas, along the courſe of the river.

The multitude and diverſity of trees, ſhrubs, and plants on the borders of the river of the Amazons, and of the other rivers that empty themſelves into it, are immenſly great; and to many of them great virtues are attributed by the natives. This at leaſt is certain, that from *hence* were obtained the bark, the ipecacuanha, ſarſaparil, guajacum, *&c.* And one would think that ſuch a treaſure already found would incite the curious botaniſt, and the beneficent phyſician to make further enquiries in a country ſo fertile.

What ſtrikes a ſtranger the moſt is the vaſt variety of creepers, ſome winding in ſerpentine folds round trees and ſhrubs, and, after having reached to a great height, ſtrikeing back again to the ground take freſh root, and ſhoot themſelves forth anew; others carried obliquely by the wind or ſome other accident ſpread themſelves from tree to tree, and forming a confuſion of cordage preſent to the ſight the ſame appearance as the tackling of a ſhip.

The gums, the reſins, the balſams, all the juices that flow by inciſion from divers ſorts of trees, and the different oils that are extracted from them, are innumerable. The roſin, called cahoutchou in the countries of the province of Quito bordering on the ſea, is likewiſe very common on the borders of the Maragnon, and ſerves for the ſame uſes. When it is freſh, they give it by moulds what

form

form they pleaſe; it is impenetrable by rain, but what renders it more remarkable is its great elaſticity. They make bottles of it, which have an advantage over glaſs in not being brittle, butts, and hollow bowls, which become flat by preſſure, and as ſoon as they are free from conſtraint reſume their former figure. The Portugueſe of Para have taught the Omaguas to make with the ſame roſin pumps or ſyringes, in the ſhape of a pear, which have no need of a piſton, but ſquirt the water, they are filled with, by ſqueezing.

We changed our canows and their equipment at St. Joachim. Mr. Maldonado and I had come from Laguna in two canows, the one 42 the other 44 feet long, and each was only 3 feet wide and formed of a ſingle trunk of a tree. We had 16 rowers divided between the two, who are placed from the head of the veſſel to about the middle; the paſſenger and his equipage are at the ſtern, and ſheltered from the rain under a canopy, made with great art by the Indians of the leaves of the palm tree interwoven.

Having changed our canows we departed from St. Joachim the 29th of July and arrived at the mouth of the Napo the 31ſt. I found the latitude to be 3 degrees 24 minutes ſouth. The difference of meridians between Paris and the mouth of the Napo I obſerved, by the emerſion of the firſt ſatellite of Jupiter that night, to be 4 hours $\frac{3}{4}$. I judged the

total breadth of the river Maragnon to be 5400 feet below the iſland, for I could not meaſure more than one arm of it geometrically: the Napo appeared to be 3600 feet wide above the iſlands, that lie diſperſed at its mouth.

After I had made my obſervations we immediately departed, and the next day in the morning the firſt of Auguſt landed, at 10 or 12 leagues diſtance from the mouth of the Napo, at *Pévas*, which is at preſent the *laſt* of the Spaniſh miſſions upon the borders of the Maragnon. Father Fritz had extended *them* more than 200 leagues lower, but the Portugueſe in 1710 got poſſeſſion of the greateſt part of that country.

The name Pévas, which the town bears where we landed, is the name of an Indian nation that now makes a part of its inhabitants; for there are collected thither Indians of divers nations and different languages; the greateſt part of the new inhabitants of Pévas, are not yet chriſtians, they are ſavages but lately drawn out of the foreſts; the work hitherto hath been to *humanize* them, which is no ſmall labour, and juſtly compared to the taming of lions:

Silveſtres homines ſacer interpreſque deorum
Cædibus et victu fædo deterruit Orpheus;
Dictus ob hoc lenire tigres, rabidoſq; leones.

I ſhall not enlarge on the manners and cuſtoms of theſe nations, and of a great number

ber of others that I have ſeen, but as far as they have relation to phyſics and natural hiſtory; thus I ſhall not ſpeak of their commerce nor induſtry; I ſhall give no deſcription of their dances, inſtruments of muſic, feſtivals, different ſorts of arms, utenſils for fiſhing and ſhooting, their odd ornaments with bones of animals, and fiſh-bones put into their noſtrils and lips; I ſhall barely mention their cheeks being made full of holes for ſtuffing *in* the feathers of birds of various colours, and ſhall dwell only on a fact that may employ the reflection of anatomiſts; which is the *monſtrous extenſion* of the lobe of the inferior extremity of the ear in ſome of theſe various nations, without the thickneſs of the ear being ſenſibly diminiſhed by it; we have been ſurpriſed to ſee what is commonly called the tip of the ear 4 or 5 inches long, and bored with a round hole an inch and half in diameter; but we were told that we ſaw nothing extraordinary in this kind. The hole being made with a fiſh bone, they inſert into it at firſt a little cylinder of wood, to which they ſubſtitute *one* that is bigger in proportion as the hole enlarges, 'till at laſt the end of the ear hangs down upon their ſhoulder. Their fineſt dreſs conſiſts in filling this hole with a large noſegay, or tuft of herbs and flowers, which ſerves them as a pendant.

The problem propoſed by Mr. De la Condamine appears to me analogous to what we ob-

ſerve of the progreſs of nature in other inſtances of a ſlow and gradual increaſe; for example, the pregnant uterus, whilſt it enlarges, doth not become thinner, but rather grows thicker by diſtenſion; and the reaſon ſeems to be the greater flux of humours derived to the part.

They reckon it ſix or ſeven days journey by land from Pevas, the laſt of the Spaniſh miſſions, to *San Paulo*, the firſt of the Portugueſe, which we performed by water in three days and three nights; in this interval you find no habitation on the borders of the river; the bed of the river enlarges *there* ſo conſiderably that one of its arms *alone* is ſometimes near a mile broad. As this great extent of water gives a vaſt power to the wind, real tempeſts riſe and frequently drown canows; we had two ſtorms in our paſſage from Pevas to San Paulo, but by the great experience of our Indians, and the frequent conveniency of putting into ſome creek or rivulet that empties itſelf into the river, and waiting 'till the ſtorm was over, we eſcaped all danger.

One of the greateſt perils in this navigation is the meeting with ſome trunk of a tree rooted up, run a-ground into the ſand or mud, and concealed under water; which would put the canow in danger of over-turning or ſplitting; as it happened to us once in drawing to land, in order to cut ſome wood whoſe virtues were boaſted of for the cure of

the

the dropſy; to avoid this inconvenience the canows keep at a diſtance from the ſhore. There is another accident much rarer, but always fatal, which you run the riſk of by keeping too near the edges of the river; this is the ſudden fall of ſome tree, either by decay, or becauſe the earth that ſupported it hath been undermined by the waters.

We reached in five days and five nights navigation from San Paulo to *Coari*; in this interval the Amazon receives on the north ſide two great and famous rivers, the firſt is the *Içа*, that riſes from the neighbourhood of *Paſto*, to the north-eaſt of Quito: the ſecond is the *Yupura*, which hath its ſources towards *Mocoa*, ſtill further north; this river is a true geographical wonder on account of the ſeveral ſingularities which are particular to it; it is the ſame as Mr. Deliſle, in his map of America, in 1703, names *Caquetà*, and hath improperly ſuppreſſed in his edition of the ſame map in 1722; it is ſtill called *Caquetà* in its upper parts, but *that* name is entirely unknown at its mouths, by which it empties itſelf into the Amazon; I ſay its *mouths*, for there are really ſeven or eight different *ones*, formed by as many arms that detach themſelves ſucceſſively from the principal canal, and ſo wide one from another, that there is near 80 leagues diſtance between the firſt mouth and the laſt; the Indians give them divers names, which hath occaſioned them

them to paſs for different rivers: one of the moſt conſiderable of its branches is called by *them* Yupura, and to conform myſelf to the uſage of the Portugueſe, who have extended this name ſtill higher up the river, I ſhall call by the name Yupura, not only the arm *ſo* named anciently by the Indians, but likewiſe the trunk from whence this branch, and all the ſucceeding ariſe; all the country through which they run is ſo low, that in the ſeaſon when the river of the Amazons ſwells, the whole country is floated: the borders of the Yupura are inhabited in ſome places by a wild and fierce people, that deſtroy one another, and ſeveral of them ſtill eat their priſoners.

In the courſe of our navigation we had enquired every where of the Indians of divers nations, whether they had any knowledge of thoſe *warlike women*, whom Orellana pretended to have met with, and whether it was true that *they* lived remote from the commerce of men, admitting them only once in the year, as father d' Acuna relates; we were told by *all* that they had heard their fathers ſay *ſo*, and added a thouſand particularities, too long to repeat, but all tending to confirm the report that there had been formerly a republic of women, that lived *alone* without the ſociety of men, and that they had retired towards the north very far within land, along the *Black River*, or near one of *thoſe* that de-

ſcend from the ſame country into the Maragnon.

I muſt own that if there ever were any Amazons, this country is the moſt likely to have excited in women the courage and reſolution of withdrawing from the ſociety of *men*, by whom they are accuſtomed to wars, and at the ſame time treated as ſlaves; however, I cannot think there are *any* ſubſiſting at preſent, but that either they have been ſubdued, or elſe tired of their ſolitude, the daughters have at length loſt the averſion of their mothers to *men*. Some of their cuſtoms, and particularly *that* of cutting off one of their breaſts, are circumſtances probably added by the Europeans prepoſſeſſed with the cuſtoms that have been attributed to the antient Amazons of Aſia,

Ducit Amazonidum lunatis agmina peltis
Penthesilea furens, mediisq; in millibus ardet,
Aurea subnectens exsectæ cingula mammæ
Bellatrix, audetque viris concurrere virgo.

The 20th of Auguſt we departed from Coari, with a new canow and freſh Indians; the ſame day, and the next day after our departure, we left on the north ſide of the river the two laſt mouths of the Yupura, and the day following we left to the ſouth the mouths of the river at preſent called *Purus*, but formerly *Cuchivara*; this river is not inferior to *any* that run into the Maragnon; ſeven or eight leagues below the entrance of the

the *Purus*, ſeeing the river without iſlands, and near 7200 feet wide, I tried to ſound the depth, but could find no bottom at 103 fathom.

On the 23d we went up a little way the *Rio Negro*, or black river, which is a ſea of freſh water that the Amazon receives on its north ſide. The map of father Fritz, who never went up the Rio Negro, and the map of America in 1722 by Mr. Deliſle, copied from father Fritz, make this river run from north to ſouth; but it is certain from the reports of all that have gone up the river, that it comes from the weſt and runs eaſtward, inclining a little to the ſouth; I myſelf ſaw that *ſuch* is its direction for ſeveral leagues above its mouth, by which it enters into the Amazon in ſo parallel a direction, that was it not for the tranſparency of its waters (which hath occaſioned the name of *black* to be given it) one ſhould take it for an arm of the Amazon, ſeparated by an iſland. At the fort built by the Portugueſe two leagues above the mouth, I meaſured the breadth of the Rio Negro in its narroweſt part, and found it to be 7218 feet, and obſerved 3 degrees 9 minutes latitude.

The Rio Negro hath been frequented by the Portugueſe for more than a century, and *they* carry on there a great trade of ſlaves; there is continually a detachment from the garriſon of Para incamped on its borders, in order

order to keep the Indians in awe, and to favour the commerce of ſlaves within the limits preſcribed by the laws of Portugal; which do not allow the depriving any one of liberty *unleſs* his condition is made better by being a ſlave; *ſuch* are thoſe unhappy captives that are appointed to be killed, and to ſerve for food to their enemies, amongſt thoſe nations that have this barbarous cuſtom, as we have mentioned before; for this reaſon the flying camp of the Black River bears the name of the *ranſom troop*.

After going up the Black River for a fortnight, three weeks or more, one finds it much larger than at its mouth, on account of the great number of iſlands and lakes that it forms; the antient map of Mr. Deliſle is in this reſpect more exact than the new. In all this interval the ground of the borders is high, and never ſubject to floods, the woods are leſs full of thickets, and in ſhort the whole country hath a different face from *that* of the borders of the Amazon.

We heard at the fort of the Black River very particular accounts of the communication of *that* river with the Orinoque, and conſequently of the Orinoque with the Amazon; I myſelf converſed with an Indian woman, whoſe habitation was on the borders of the Orinoque, and who had been brought from her own houſe in a canow to Para, all the way by water. Since my return I have received

received an account in a letter ſent me from Para by the Rev. father John Ferreyra, rector of the college of Jeſuits, that the Portugueſe of the flying camp on the Black River, having gone up from river to river, met laſt year, 1744, the ſuperior of the Jeſuits of the Spaniſh miſſions on the borders of the Orinoque, with whom the Portugueſe had returned by the ſame paſſage; and without landing, quite to their camp on the *Black River*, *which* mediates the intercourſe of the Orinoque with the Amazon; this fact therefore can be no longer doubted.

The communication of the Orinoque and the Amazon, *thus* recently atteſted, may paſs for a kind of diſcovery in geography; as the connexion of theſe two rivers, although marked without *any doubt* in antient maps, hath been univerſally ſuppreſſed by modern geographers in the new, and treated as chimerical.

It is in that iſland, the greateſt of the known world, formed by the Amazon and Orinoque connected by the Black River, and which may be called the *Meſopotamia of the new world*, that there have been long ſought a pretended golden lake of *Parima*, and an imaginary city of *Manoa del Dorado*; a ſearch that hath coſt the lives of ſo many men, and amongſt the reſt of Sir Walter Raleigh, a famous navigator, and one of the fineſt geniuſſes of England, whoſe tragical hiſtory is ſufficiently known.

The

The clear cryſtal waters of the Black River had ſcarce loſt their tranſparency, by mixing with the whitiſh and muddy waters of the Amazon, before we ſaw on the ſouth ſide the firſt mouth of another river, that is very little inferior to the preceding, nor is it leſs frequented by the Portugueſe: they have named it *Rio da Madeira* or river *of wood*; in order to give an idea of the extent of its courſe, it is ſufficient to mention that in 1741 they went up this river as far as the neighbourhood of Santa-Cruz de la Sierra, an epiſcopal city of the upper Peru, ſituated 17 degrees and half of ſouth latitude.

The Amazon below the mouth of the *Madeira* is commonly a league broad; it is *here* that the Portugueſe of Para begin to give it the name of River of the Amazons. Above *that* they call it *Rio de Solimoes* or river of *poiſons*, probably on account of the poiſoned arrows.

On the 28th we paſſed the mouth of the river *Jamundas*, lying on our left; father d'Acuna names it *Cunuris*, and pretends it to be the river where Orellana was attacked by thoſe warlike women, whom he called Amazons.

A little below on the ſame ſide we landed at the foot of the Portugueſe Fort of *Pauxis*, where the bed of the river is confined within a ſtreight about a mile broad. The tide reaches as far as this ſtreight, at leaſt it is perceivable

perceivable *there* by the ſwelling of the waters of the river, which is to be remarked every twelve hours, and is every day later as on the coaſt.

The utmoſt height of the tide, which I meaſured at Para, is but 10 feet and $\frac{1}{2}$ in the greateſt ſpring-tides: but it is not to be concluded from thence that the river from Pauxis to the ſea, which is a courſe of 200 leagues and upwards, hath no more than 10 feet and $\frac{1}{2}$ declivity; altho' ſuch a concluſion would appear to correſpond with the height of the mercury, that I obſerved at the Fort of Pauxis (which is 14 fathom above the level of the water) to be about 1 line $\frac{1}{4}$ leſs than at Para on the ſea ſhore.

The 2d of September we departed from Pauxis; on the 5th in the evening I obſerved at ſun-ſet the variation of the compaſs 5 degrees and half to the eaſt. As we could find no proper place to land at, I made my obſervation on the trunk of a tree rooted up, which the current had driven on the edge of the river. We had the curioſity to meaſure it and found its length between root and branches 84 feet, and its circumference 24, altho' it was withered and ſtripped of its bark. By this tree which mere chance offered us, by the ſize of their ſhallops, called *pirogues*, made out of the ſingle trunk of a tree, and by a table of a ſingle piece 8 or 9 feet long, upon 4 and half broad, of an hard and poliſhed

wood, which we ſaw at the governor's houſe at Para; one may judge of the loftineſs and beauty of the woods on the borders of the Amazon and of ſeveral rivers that join themſelves to it.

I ſhould have mentioned that on the 4th of September we began to ſee ſome mountains on the north ſide, at ſome leagues within land. It was a new ſight to us, who had been navigating from the Pongo two months without ſeeing the leaſt hill.

The moſt troubleſome thing in the whole courſe of our navigation was the prodigious number of gnats and flies of all ſorts; there are ſeaſons and places, particularly in the country of the Omaguas, where you are continually enveloped with a thick cloud of theſe flying inſects, whoſe ſtings cauſe an exceſſive itching.

The *greateſt* known fiſh of freſh water is that to which the Spaniards and Portugueſe have given the name of *pexe-buey (ox-fiſh)* but it muſt not be confounded with the *phoca* or *ſea-calf*. This I am ſpeaking of feeds on graſs of the borders of the river Amazon. Its *fleſh* and *fat* very much reſemble *thoſe* of veal; the female hath dugs with which ſhe ſuckles her young. Father d'Acuna makes the reſemblance of this fiſh to the ox ſtill more complete, by attributing to it horns, which nature hath not armed it with. Properly ſpeaking, it is not amphibious, ſince it

never comes intirely out of water, neither can it, having only two fins ſituated pretty near the head, which are flat and round in form of oars 15 or 16 feet long, and ſupply the place of arms and feet without having their ſhape. It only puts forth its head out of water, to reach the graſs along the bank. That which I drew the figure of at St. Paul d'Omaguas was a female, her length was ſeven feet and half, and her breadth two. I have *ſince* ſeen much larger. The eyes of this animal bear no proportion to the ſize of its body, they are round and have no more than three lines in diameter; the perforation of the ears is ſtill ſmaller, and ſeems no bigger than the point of a pin. Some have thought this fiſh particular to the river of the Amazons, but it is not leſs common in the Orinoque. It is the ſame as was called formerly *Manati*, and is at preſent named *Lamentin* in the French iſlands of America; it is not found *at* ſea, and rarely ſeen near the mouths of rivers, but you find it at above a thouſand leagues diſtance from the ſea in the Guallaga, Paſtaca, *&c.* In the Amazon it is ſtopped by the Pongo, above which you find it no more.

I have ſeen in the neighbourhood of Para a fiſh called *paraquè*, the body of which, like the lamprey, is full of holes, and which hath moreover the ſame property as the torpedo. Whoever touches it with the hand or even

with

with a ſtick, feels a painful numbneſs in the arm, and is ſometimes, they ſay, knocked down by it; I have never ſeen this laſt fact, but inſtances of it are ſo frequent that it cannot be doubted. Mr. De Reaumur hath diſcovered the ſecret ſpring, by which the torpedo cauſes ſo ſurpriſing an effect; and without doubt a like mechaniſm produces it in the fiſh we are ſpeaking of.

The turtle fiſh of the Amazon are in great requeſt at Cayenne, as more delicate than any others. There are of divers ſizes and different ſpecies, and in ſuch abundance that they alone and their eggs would ſuffice for food to the inhabitants on the borders. There are likewiſe land tortoiſes called *jabutis* in the language of Brazile, and which are preferred at Para to the other ſorts. All, but particularly the laſt, will live ſeveral months out of water without any perceptible food.

Nature ſeems to have favoured the indolence of the Indians, and to have prevented their wants; the lakes and moors that you find all along the borders of the Amazon, and ſometimes very far within land, are filled with all ſorts of fiſh at the time the river ſwells and over-flows its banks, and when the waters ſubſide, they continue *there* confined as in ponds or natural reſervoirs, where you may catch them with the greateſt eaſe.

In the province of Quito, in the divers countries traverſed by the Amazon, at Para,

and at Cayenne, one finds ſeveral ſorts of plants, different from any known in Europe, whoſe leaves or roots thrown into the water have the property of making the fiſh drunk. The plant moſt commonly made uſe of for this purpoſe is called at Quito and Maynas *barbaſco*. They pound it ſmall and mix it with ſome bait; the fiſh that eats of it grows drunk, floats upon the water, and may be taken with the hand.

Crocodiles are very common in the whole courſe of the Amazon, and likewiſe in the greateſt part of the rivers which the Amazon receives. I have been aſſured there are *ſome* 20 feet long. I have ſeen a great number from 12 to 15 and upwards on the river of Guayaquil. At the time of inundations they ſometimes enter into the huts of Indians, and there are ſeveral inſtances of this fierce animal taking a man out of a canow and devouring him in ſight of his companions, without their being able to aſſiſt him.

The moſt dangerous enemy of the crocodile and perhaps the only one that dares enter the liſts with him is the tiger. It muſt be a fine ſight, and ſuch an one as extreme good fortune alone can preſent, to ſee ſecurely their combat; but this is what the Indians relate of it: when the tiger comes to drink on the border of the river, the crocodile puts his head out of the water to ſeize him, as he attacks on a like occaſion oxen, horſes, mules,

mules, and all that offer themſelves. The tiger ſtamps his claws into the eyes of the crocodile, which is the only place that is penetrable on account of the hardneſs of his ſcales; the crocodile plunging immediately into the water drags the tiger after him, who ſuffers himſelf to be drowned rather than quit his hold. The Indian Maynas are very dextrous in fighting tigers with a ſpontoon, or half pike, which is their common inſtrument of defence in travelling.

I never ſaw any lions on the borders of the Amazon; and thoſe which are called lions in the province of Quito, are of a different ſort from the African. The male hath no mane, and is much ſmaller than *thoſe* of Africa.

Bears, which are inhabitants of cold countries, and found on ſeveral mountains of Peru, I did not meet with in the woods of the Maragnon, whoſe climate is ſo different: yet I have heard them *there* mention an animal by the name of *ucumari*, which is preciſely the term for a bear in the language of Peru; but I had no opportunity of being aſſured whether it is the ſame animal.

The largeſt native quadruped of ſouth America is what the Spaniards of Peru call *danta*, and the Portugueſe of Para *ante*; it is not ſo bulky as an ox, and hath no horns.

Apes are the moſt common game and the moſt pleaſing to the taſte of the Indians on

the borders of the Amazon. They have vaſt numbers and great varieties of them; ſome are as large as a greyhound, and others as ſmall as a rat.

It is not ſurpriſing that in countries ſo hot and moiſt as thoſe we are ſpeaking of, ſerpents and adders of all kinds ſhould be common. The moſt rare and ſingular of this kind is a great amphibious ſerpent from 25 to 30 feet long, and more than a foot in bigneſs, as I have been aſſured. I ſhall only mention what hath been related to me, tho' I muſt own it appears incredible, and I ſhould not dare to repeat it had I not the authority of a late author in his *Orinoque illuſtrated*. Not only, according to the Indians, this monſtrous adder ſwallows a roe-buck entire, but they affirm that it attracts invincibly by its breath whatever animals approach it, and devours them. Divers Portugueſe of Para would have perſuaded me of things almoſt as improbable, namely, of the manner in which a certain large adder kills a man by twiſting round his body and impaling him with its tail. To judge of it by the ſize, it may very well be the ſame ſort of adder as is found in the woods of Cayenne, where experience hath taught us that it is more frightful than dangerous. I knew an officer *there* that had been bitten by one of theſe adders in the leg without any bad conſequences: perhaps, however, he was not bitten ſo far as to touch

the blood. I have brought home with me the ſkins of two of theſe adders, of which one, dried as it is, hath near fifteen feet in length and more than a foot in breadth; without doubt there are *ſome* much larger.

The number of different ſorts of birds in the foreſts of the Amazon is greater and more various, than that of the quadrupeds: It is remarked that there is ſcarce any of them that have an agreeable melody; and it is chiefly on account of the ſplendor and diverſity of colours in their plumage that they are to be admired. Nothing equals the beauty of the feathers of the *colibri*, or *bird-fly*, which lives only on the juices of flowers. Several authors have ſpoken of it, and it is found in America throughout the whole torrid zone. I ſhall only obſerve that altho' it is commonly reputed to inhabit the hot countries alone, yet I no where ſaw a greater quantity than in the gardens of Quito, whoſe temperate climate borders rather on cold, than exceſſive heat. It is named in the language of the country *quindé*. The Spaniards call it *pica-flor*.

The *toucan*, whoſe red and yellow bill is *monſtrous* in proportion to his body, and whoſe tongue, which reſembles a delicate feather, is accounted to have great virtues, is not peculiar to this part of the country I am ſpeaking of.

The ſorts of parrots different in ſize, colour, and ſhape, are innumerable. The Indians on the borders of the Oyapoc have the ſkill of procuring to parrots *artificially* natural colours, different from thoſe which they received from nature, by drawing out feathers in different places on the neck and back, and rubbing the part plumed with the blood of certain frogs. Perhaps the *ſecret* conſiſts only in wetting the part plumed with ſome acrid liquor, or perhaps there is no need of any ſuch preparation; but *that* deſerves trial. In reality, it doth not appear more extraordinary to ſee *red* or *yellow* feathers riſe up in the places of *green* that have been plucked off from a bird, than to ſee *white* hair ſhoot up in the place of *black*, on the back of an horſe that hath been galled.

The bird called *trompetero* by the Spaniards in the province of Maynas is the ſame as is named *agami* at Para and Cayenne: it hath nothing particular but the noiſe it makes ſometimes, which hath cauſed the name to be given it of *trumpet* bird. Some have very improperly taken this ſound for a tune or chirping; but it is evidently formed in an organ quite different, and preciſely oppoſite to *that* of the throat.

The famous bird called at Peru *contur* and by corruption *condor*, that I have ſeen in ſeveral places of the mountains in the province of Quito, is found likewiſe, if I am rightily informed,

informed, in the low countries along the borders of the Maragnon; it is the greateſt bird that wings the air, will take up commonly a lamb in its talons, even a roe buck as it is ſaid, and hath ſometimes made its prey of a child; I have ſeen it hovering over a flock of ſheep, whilſt the ſhepherds in conſternation hooted to frighten it away, and prevent its ſeizing any of their flock; ſuch as the eagle is deſcribed by Virgil, in the rape of Ganymed,

——*Quem præpes ab Idâ*
Sublimem pedibus rapuit Jovis Armiger uncis:
Longævi palmas nequicquam ad ſidera tendunt
Cuſtodes, ſævitque canum latratus ad auras.

The Indians lay ſeveral ſorts of ſnares for it; the moſt ingenious of all that I have heard conſiſts in offering it for a lure, the figure of a child made of a very viſcous clay, at which the *contur* ſtooping ſtrikes with ſo rapid a force, that he faſtens his talons in ſuch manner, as makes it impoſſible for him to diſengage himſelf.

The *bats*, that ſuck the blood of horſes, mules, and even of men, when they do not ſecure themſelves from them by ſleeping under the ſhelter of a tent, are a common plague to the greateſt part of the hot countries of America; there are *ſome* monſtrous for their ſize; they have entirely deſtroyed at Borja, and in divers other places, the black cattle

cattle that the miſſionaries had introduced thither, and which began to multiply; they ſting or rather bite in the night theſe animals, and fill themſelves with blood, which continues to flow from the wound 'till it ſtanches of itſelf; theſe bleedings often repeated cauſe the animal to waſte away; it is ſaid that they make theſe wounds without giving any pain, at leaſt ſo much as to wake a man that is aſleep; many ſtories are related of ſuch ſort of accidents, but I knew none myſelf that proved fatal.

On the 19th of September, above 4 months after my departure from Cuenca; I arrived in ſight of the *Para*, which the Portugueſe call the *great Para*, that is to ſay, the *great River* in the language of Brazile.

We thought ourſelves at our arrival at Para, after having been ſo long accuſtomed to the woods along the Amazon, tranſported of a ſudden into Europe; we found a large city with very regular ſtreets and agreeable houſes, the greateſt part of them having been rebuilt within theſe 30 years with ſtone, and magnificent churches.

The latitude of Para had probably never been taken at land, and I was aſſured at my arrival that I was preciſely under the equinoctial line. The map of father Fritz places this city at 1 degree ſouth latitude, and the new Portugueſe ruttier at 1 degree 40 minutes: I found by ſeveral correſponding obſervations

ſervations 1 degree 28 minutes; which doth not differ ſenſibly from the latitude in Laet's map, that hath not been followed however by any later geographer: I found the declination of the compaſs a little more than four degrees north-eaſt; it was much *greater* in the laſt century, and appears to be *decreaſing* continually on the north coaſt of South America; the little knowledge they had about a century ago of the variations of the compaſs, hath without doubt contributed to the errors of maps, which have given falſe *directions* to the mouth of the river of the Amazons, and to the coaſt as far as Cape de Nord.

The ſmall-pox was very rife at that time at Para; it is remarked that this diſeaſe is more fatal to the Indians of the miſſion, newly drawn out of the woods, and who go naked, than to the Indians that are cloathed, and who were born, or have a long time dwelt amongſt the Portugueſe: the former, a kind of amphibious animals as often in water as on land, hardened from their infancy to the injuries of the weather, have probably their ſkin more compact than *that* of other men; and this circumſtance alone may occaſion in *them* the eruption of the ſmall-pox to be more difficult. The cuſtom theſe ſame Indians have of beſmearing their bodies with oils and greaſy ſubſtances, which muſt obſtruct the pores, may contribute likewiſe to increaſe that difficulty; this conjecture is confirmed by

by another remark, *namely*, that the negro ſlaves tranſported from Africa, who have not this cuſtom, bear this diſorder better than the natives of the country; but whatever be the cauſe, an Indian ſavage, newly taken out of the woods, ſeized in the natural way with this diſorder, is commonly reputed a dead man. How comes it to paſs that it is not ſo in the artificial ſmall-pox? About twenty years ago a miſſionary Carmelite near Para, was the firſt in America that had the courage to put inoculation in practice; he had already loſt the half of his Indians, and many of the remaining were falling ill every day; he prudently dared therefore to inoculate the reſt, having learnt the method of inoculation, and being aſſured of its ſucceſs in Europe by reading the gazette; all thoſe who were not yet attacked with the diſorder he inoculated, and did not loſe a ſingle perſon; another miſſionary of the Black River followed his example, and with the ſame ſucceſs.

After ſuch authentic proofs of the virtue of inoculation, the reader will judge no doubt that in the contagion of 1743, all thoſe who had Indian ſlaves would make uſe of a method ſo ſalutary for preſerving them; yet *to the diſgrace of human underſtanding*, it was abſolutely neglected, at leaſt it was not put in practice when I departed; perhaps the *time* was not yet come, they muſt firſt loſe the

the half of their Indians: ſince my return, an account hath been received by letters from Para, that inoculation had been practiſed with the ſame ſucceſs as at the firſt trial.

On the 29th of December I embarked at Para on board a deck-canow with twenty-two rowers for Cayenne; ſome leagues below Para I croſſed the eaſtern mouth of the Amazon, or, to ſpeak more properly, the river of Para, which is ſeparated from the true mouth of the Amazon, by the great iſland known under the name of *Joannes*, and more generally at Para under the name of *Marago*; which, perhaps, is nothing but a vitious pronunciation of Maragnon.

This iſland occupies the whole ſpace that ſeparates what they commonly call the two mouths of the river; it abounds in paſturage, where they fatten a prodigious number of the large cattle, which are conſumed at Para, and throughout all the colony. The iſland is of an irregular figure, and hath more than 150 leagues in circumference: in all maps they have ſubſtituted in its place a multitude of little iſlands, that one would think *placed* at hap-hazard, if they did not appear to be copied from the chart of *Flambeau de la Mer*, a book tranſlated into all languages, which is filled in this part with details as falſe as they are circumſtantial.

In my paſſage the canow ſtruck upon a ſhallow, and we were obliged to wait ſeven days

days for a ſpring tide to carry her off again. Between Macapa and Cape de Nord, the ſpring tides come *in* of a ſudden, in one or two minutes to their greateſt height; I examined this phenomenon with attention, and found it to be owing to a bank of ſand or high ground, that I ſuppoſe is nearly on a level with the height of the tide, which the waters having ſurmounted come pouring down *in mountains* with a prodigious rapidity, and ſweep away every thing in their paſſage. I am told that the like thing happens at the Orknies to the north of Scotland, and at the mouth of the Garone near Bourdeaux.

My canow being faſtened in the mud became a kind of fixed obſervatory; I found the variation of the compaſs four degrees north-eaſt, which is nearly the ſame as at Para.

If you take on one ſide Cape de Nord, on the continent of Guiana, and on the other the point of Maguari, in the iſland of Marago, for the meaſure of the mouth of the Amazon (which in my opinion is the greateſt extent that can be allowed it) I found that a ſtraight line drawn from one of theſe points to the other is little leſs than two degrees and an half, that is to ſay, near fifty leagues, *allowing* twenty to a degree.

After a tedious delay on the ſhole, and getting off not without danger, I paſſed by the river and bay of *Vincent Pinçon*. The Portugueſe of Para have had their reaſons for confounding

confounding this river with the river Oyapok, the mouth of which under Cape d' Orange, is at 4 degrees 15 minutes north latitude. The article of the treaty of Utrecht, that ſeems to make of the Oyapok, under the name of *Yacopo*, and of the river of Pinçon, one and the ſame river, doth not hinder them from being really fifty leagues aſunder. At length after two month's navigation along the coaſt, which is ſo flat between Cape de Nord, and the iſland of Cayenne, that the rudder was continually ſtriking into the mud, there not being ſometimes a foot water at half a league diſtance from the ſhore; I arrived at Cayenne the 26th of February 1744.

It is well known that it was in this iſland Mr. Richer, a member of the academy, made in 1672, the diſcovery of the inequality of *gravity* under different parallels, and that *his* experiments have been one of the firſt foundations of the theories of Mr. Huygens, and Sir Iſaac Newton, on the figure of the earth. *Vid. Newtoni principia*, *Prop.* xx. *Prob.* iv.

One of my principal motives for going to Cayenne, was the uſefulneſs there might be in repeating the experiments of the pendulum; in which kind of operations *we* had been much exerciſed, and which are performed at preſent with greater exactneſs than formerly.

I have not yet compared the vibrations of the pendulum at Cayenne, with the number of

of its vibrations *in an equal time* at Paris; but have deferred it for the ſake of greater exactneſs, 'till the arrival of the individual rod of metal that I made uſe of at Cayenne [a]. The difference of the number of oſcillations of the ſame Pendulum in 24 hours, at Para, Quito, and Paris, taken from a long ſeries of experiments in each place, will give the abſolute *meaſure* of the equinoctial pendulum on the ſea-ſhore, *which* is the moſt proper of all to be by general agreement *the common meaſure of nations*; a thing greatly deſirable in the commerce of the philoſophical world!

I obſerved at Cayenne the ſame latitude as Mr. Richer, about 4 degrees 56 minutes north; but was ſurpriſed to find by four obſervations of the firſt ſatellite of Jupiter, which entirely correſponded together, the difference of meridians, between Cayenne and Paris, about a degree *leſs* than it is marked by Mr. Richer. I have ſince found that Mr. Richer had made no obſervation of the ſatellites of Jupiter at Cayenne, and that the longitude of the place had not been deduced in a manner agreeable to his other obſervations, but in a way very indirect and very liable to error.

Having remarked that from Cayenne the mountains of *Courou* could very diſtinctly be ſeen, the diſtance of which was reckoned ten

[a] N. B. In the year 1747. Mr De la Condamine reported to the academy that his experiments intirely accorded with thoſe of Mr. Richer.

ten leagues; I thought thoſe mountains, from whence the fire could be perceived and the noiſe of the cannon from the fort of Cayenne could be heard, a proper place to meaſure the velocity of ſound in a climate ſo different from Quito, *where* we had made ſeveral experiments of the ſame kind. By the favour and aſſiſtance of Mr. d'Orvilliers the governor of the fort, and of Mr. Freſneau the king's engineer, I made five experiments on the firſt and ſecond of April, four of them agreed within half a ſecond, upon an interval of 110 ſeconds of time, and I found the velocity of ſound, deducting the velocity of the wind, by a geometrical meaſure of the diſtance, to be 1101 feet in a ſecond, inſtead of 1050 which we had found at Quito. The velocity of the wind, which was *low*, we eſtimated at a *medium* between the meaſures taken at Cayenne and Courou; but it is poſſible that in the intermediate ſpace, which was eight leagues, the velocity of the wind might have been different from our eſtimation. It is very difficult to remedy this inconvenience in experiments made at great diſtances.

Memoirs 1745, *pag.* 393.

It is very remarkable that all who have given experiments of the velocity of ſound have differed ſo widely from each other, that one would think it almoſt impoſſible for philoſophers

to err ſo much. For inſtance, the academy del Cimento gives it at the rate of 1185 *feet in a ſecond; Mr. Boyle at* 1200; *Sir Iſaac Newton at* 968; *and Mr. Derham at* 1142. *Query, From whence doth this great diverſity ariſe? May not the pendulum itſelf vary by the different condenſation of the air, as well as by the different temperatures? For it muſt be ſuppoſed that experiments of this kind are made when the wind is extremely ſtill, or at leaſt that proper allowances are made for the wind. It ſeems to me very reaſonable to think from analogy, that the different denſity of the medium in which the pendulum ſwings ſhould occaſion a proportionate difference in its vibrations; yet I am inclined to believe that experience doth not confirm my conjecture: and therefore I own myſelf at a loſs to account for the great variation amongſt philoſophers on the velocity of ſound, which is a mere experimental enquiry.*

Mr. De la Condamine found that his pendulum at Para performed in 24 *hours time,* 31 *or* 32 *vibrations more than at Quito, and* 50 *or* 51 *vibrations more than at Pichincha; from whence he concludes, that under the equator two bodies, the one weighing* 1600 *pounds, the other* 1000 *on a level with the ſea, being conveyed, the firſt* 8700, *the ſecond* 13200 *feet high, would each loſe more than a pound of their weight, agreeably to the Newtonian ſyſtem.*

The

The reader will be pleaſed to obſerve, that in ſpeaking of feet and fathom, I always mean the French foot and fathom; the French foot exceeds the Engliſh by ſeven lines and an half, or is as 107 *to* 114: *and the French fathom,* toiſe *and* braſſe, *muſt be larger in the ſame proportion.*

A diſcovery of the male toad performing the office of a man-midwife to the female.

We could wiſh for the ſake of ſome readers that what we have to offer on this ſubject related rather to pigeons and turtle-doves, than to a ſort of animals that one cannot ſee or even think of *in general* without horror. But the imagination and eyes of a philoſopher are not ſo delicate, they are accuſtomed to ſee nature act differently from what our taſtes and prejudices would preſcribe to her, and frequently give a preference to animals that are the moſt contemptible in appearance, and the moſt hideous.

The occaſion of the memoir that Mr. Demours, a phyſician, read to the company on this ſubject, was one of thoſe *lucky chances* which naturaliſts alone can know the value of.

In the evening of one of the long days in ſummer, Mr. Demours being in the king's garden perceived two toads *coupled together* at the edge of an hole, which was formed in part by a great ſtone at the top.

Curioſity drew him to ſee what was the occaſion of the motions he obſerved, when two facts equally new ſurprized him; the

firſt was the extreme difficulty the female had in laying her eggs, inſomuch that ſhe did not ſeem capable of being delivered of them without ſome aſſiſtance. The *ſecond* was, that the male was mounted on the back of the female, and exerted all his ſtrength with his hinder feet in pulling out the eggs, whilſt his fore-feet embraced her breaſt.

In order to apprehend the manner of his working in the delivery of the female, the reader muſt obſerve that the paws of theſe animals, as well thoſe of the fore-feet as of the hinder, are divided into ſeveral toes, which can perform the office of fingers.

It muſt be remarked likewiſe, that the eggs of this ſpecies of toads are included each in a membranous cod that is very firm, in which is contained the embryo; and that theſe eggs, which are oblong and about two lines in length, being faſtened one to another by a ſhort but very ſtrong cord form a kind of chaplet, the beads of which are diſtant from each other about the half of their length. It is by drawing this cord with his paw that the male performs the function of a midwife, and acquits himſelf in it with a dexterity that one would not expect from ſo lumpiſh an animal.

The preſence of the obſerver did not a little diſcompoſe the male; for ſome time he ſtopped ſhort, and threw on the *curious impertinent* a fixed look that marked his diſquietneſs

quietneſs and fear; but he ſoon returned to his work with more precipitation than before, and a moment *after* he appeared undetermined whether he ſhould continue it or not. The female likewiſe diſcovered her uneaſineſs at the ſight of the ſtranger, by motions that interrupted ſometimes the male in his operation. At length, whether the ſilence and ſteady poſture of the ſpectator had diſſipated their fear, or that the *caſe* was urgent, the male reſumed his work with the ſame vigour, and ſucceſsfully performed his function.

The curioſity of Mr. Demours had another object in view; he obſerved attentively whether the male, as he drew out the eggs, did not beſprinkle them with his ſeminal liquor: for it is by ſuch a ſprinkling, according to the accounts of ſeveral authors, that the eggs or ſpawn of aquatic and amphibious animals are impregnated, and particularly the eggs of frogs as Swammerdam hath related. But as Mr. Demours did not perceive any thing like it in the two toads that were coupled, and as the place where he found them was a little darkiſh, he determined to put them on his hand. In conſequence of which the work was again interrupted for ſome moments, but reſumed afterwards as before. The male however did not give the leaſt ſign of what the obſerver had expected to diſcover by his eyes, or to

feel upon his hand, where he held them for a quarter of an hour.

Swammerdam hath related that the *male* of frogs affiſts likewiſe the *female* in laying her eggs; but it appears to be in a manner leſs continued, leſs perfect, and leſs deciſive than the toad; in ſhort, it doth not appear clearly that this aid is abſolutely neceſſary to the frog. Perhaps it conſiſts only in giving her a ſqueezing at the inſtant, for the female frog is delivered *immediately* of all her eggs, as the ſame naturaliſt hath obſerved, *uno impetu omnia ejaculatur.*

It is pity that ſome naturaliſts, who have been extremely eager of perſuading us that it is to the *brutes* we owe originally our mechanical and liberal arts, as well as the more ſublime ſciences and particularly phyſic, had not been appriſed of the fact we have been relating; they would without doubt have derived from thence the art of midwifery, and *the practice of men-mid-wives.*

Hiſtory 1741, *pag.* 28.

Of inſects that multiply without the conjunction of ſexes.

There are *copulations* of inſects which cannot be perceived, altho' very certain, becauſe they are performed in ſecret places and impenetrable to our ſight: there are *others* which we are ignorant of and have not ſeen, for want of a method of ſeeing them, and the knowledge of the times and circumſtances wherein they may be obſerved. But whatever

ever difficulty there may be in diſcovering the manner of the copulation of certain inſects, and whatever diverſity in the method of it, all modern naturaliſts ſeemed to be agreed in conſidering the concurrence of individuals for the propagation of each ſpecies as an indiſpenſable condition, and as one of thoſe general laws that nature had never been ſeen to infringe. If any ſpecies of animals ſeemed requiſite to be excepted, it was *that* of hermaphrodites; but it hath been remarked even in the firſt years of our hiſtory, that the moſt acknowledged *hermaphrodite* inſects, ſuch as ſnails and earth worms, were not leſs ſubject to this law, under particular modifications and varieties.

Yet there is now diſcovered an exception to the general law, and an exception that may probably be attended with ſeveral others. Mr. De Reaumur gave ſome years ago the hiſtory of a kind of inſect very common in the country and in our gardens, called a *vine-fretter*, which is a little viviparous animal that attaches itſelf to buds, flowers, and ſhoots of plants, oftentimes winged, and ſometimes without wings. Mr. De Reaumur ſuſpected at that time, by ſeveral marks which would have been ſufficient to have *determined* an obſerver leſs ſkilful and leſs exerciſed in doubting, that the *vine-fretters* produced their young without having had any copulation, or any ſort of commerce

with each other, or with any other insect whatever of any sensible bigness. He tried proper methods to assure himself of it; but divers accidents having caused the death of the *vine-fretters* that he kept solitary, before they arrived at the age wherein they produce their young, he wrote of it to several of his correspondents for natural history, exhorting them to repeat the experiment with all the precautions that it required. Mr. Bonnet of Geneva hath been the first to acquit himself of this delicate commission, and hath proved the fact by a thousand observations, which required no less patience than sagacity: since *that* Mr. De Reaumur hath been fully convinced of it himself with regard to the *vine-fretters* on poppy flowers; and he promises to give a detail of it in one of his volumes on insects. Vid. tom. vi. pag. 523.

History 1741, *pag.* 32.

One of the pleasures in reading natural history is to observe, that there is scarce an instance in all the wildness of fiction in the ancient fables, but nature offers something of the like kind to countenance the seeming extravagance. I have already mentioned the similitude between the fabled birth of Bacchus and the real production of soles, pag. 119. *The example of the vine-fretters in like manner corresponds to that charming description in Virgil of the mares,*

that

that muſt ſeem abſurd without the aid of philoſophy;

Ore omnes verſæ in zephyrum ſtant rupibus altis,
Exceptanque leves auras; et ſæpe ſine ullis
Conjugiis vento gravidæ (mirabile dictu)
Saxa per et ſcopulos et depreſſas convalles
Diffugiunt.

What is there in this poetic marvel, that nature doth not juſtify in the little inſect we have been deſcribing? One reads poetry with an additional pleaſure, when it is diſcerned that the fables do not exceed the bounds of nature, but are, as old Heſiod expreſſes it,

——— ἐτύμοισιν ὁμοῖα.

An account of an inflammable rivulet.

The deceaſed Mr. Raoul, a counſellor of the parliament at Bourdeaux, ſent an account to Mr. De Reaumur by a letter dated in July of the laſt year, that there was in the priory of Tremolac of the order of Clugny, at five leagues diſtance from Bergerac, an inflammable and burning rivulet, which was diſcovered about four years ago by a fellow that went to ſteal craw-fiſh, who in order to find the holes where they conceal themſelves, made uſe of torches of ſtraw *lighted*. Whilſt the man walked on the gravel of the bed of the river, almoſt horizontal to the water, the fire did not catch hold of the ſurface; but when he got into places uneven and full of hollows, he was extremely ſurpriſed to ſee that

that the water was all in flames, insomuch that his shirt was burnt by it: it was a bluish flame. The abbot d'Alême, who was then prior of Tremolac, caused the experiment to be repeated twice or thrice, and it succeeded in the same manner. It is probable that there hath fallen, and is collected into these hollow places a mud loaded with a sulphureous matter, which is sufficiently in agitation to exhale *through* to the upper surface of the water, and *there* to catch fire at the least approach of any flame.

History 1741, *pag.* 36.

Here likewise, agreeably to my former observation, the phlegethon of the ancients finds its parallel, and receives new beauty from its evident conformity to nature.

Mœnia lata videt triplici circundata muro,
Quæ rapidus flammis ambit torrentibus amnis
Tartareus phlegethon, torquetque sonantia saxa. Æneid vi.

And Silius Italicus,

——laté exundantibus urit
Ripas sævus aquis phlegethon, et turbine anhelo
Flammarum resonans saxosa incendia torquet. Lib. 13.

N.

N. B. *The hiſtory of the polypus, and the new opinion concerning the origin of coral, which was eſpouſed by ſeveral members of the academy, having been lately diſcuſſed by the Royal Society, the firſt in the year* 1741, *and the latter in the laſt publiſhed tranſactions: I ſhall refer the reader thither to ſee thoſe ſubjects very curiouſly handled.*

A new theory of the evaporation of liquids.

It is commonly ſuppoſed that from a liquid expoſed to the air, there continually riſe imperceptible particles into the air, which do not fall back again upon the liquid from whence they aroſe, although there be not the leaſt breath of wind to diſſipate them. In order to ſolve this riſe of vapours, it is ſaid, that all the parts of the liquid, of water for example, as long as it continues in its liquid ſtate, are in a continual motion; that this motion is circular or nearly *ſo*, and that on this account the imperceptible parts, which are on the ſurface, muſt riſe up and fly off in a tangent. This ſolution ſeems to explain pretty well the reaſon why minute particles are continually detached from water that is expoſed to the air.

But whence comes it that theſe particles after having loſt the agitation, which had ſeparated them from the maſs of liquid, and darted them into the air, do not fall back again on that liquid body by their own proper

per weight? It is *this* that forms a difficulty which is extremely embarraſſing; for every one knows that the parts of water, and of every other liquid, how ſmall ſoever they may be, weigh bulk for bulk much more than the particles of air.

To ſolve this difficulty Mr. Mariotte, Dr. Halley, and ſeveral other philoſophers, have propoſed different hypotheſes, which it would be too long to diſcuſs in this place. Mr. Bouillet, a phyſician, profeſſor of mathematics, and ſecretary of the academy of ſciences and belles-lettres at Beziers, is content with propoſing his own hypotheſis, in which the main difficulty is obviated; and his ſolution may be conſidered as *new*, altho' it is only a conſequence or an extenſion of a theory already eſtabliſhed in the volume of our hiſtory for the year 1731, pag. 12th, *namely*,

"A liquid," ſays the celebrated Mr. De Fontenelle in recording the ſentiments of Mr. De Reaumur, "takes *in* air, as the tip of a "little piece of cloth ſucks up water in "which it is dipped. The air being wetted "by the firſt ſurface of the liquid incorpo-"rates itſelf with it, hath no longer any "motion but what it receives from the li-"quid, and by *that* motion the particle of "air that before touched the ſurface is now "carried *elſewhere*, ſinks deep within the "liquid, and a *new particle* of air ſucceeds "in its place at the upper ſurface, *which* is

"in

" in like manner wetted by the liquid, mixes " itſelf with it; and *thus* in a continued ſe- " ries 'till the liquid hath imbibed all the air " that it is capable of imbibing."

Since water imbibes and abſorbs the air that touches its ſurface, lodges it in its interſtices, making *no longer* but one body together; carries it along by its motion of fluidity to the bottom of the veſſel that contains it; and ſince air, notwithſtanding its ſpecific gravity, which is much leſs than *that* of water, unites itſelf with it; it follows neceſſarily, that air *may* take up, abſorb, and imbibe water on which it floats, and againſt which it is continually urged by the whole weight of the atmoſphere; and that water, notwithſtanding its greater ſpecific gravity, *may* inſinuate itſelf into air, unite with it, follow all its motions, and make but an uſeleſs effort to fall back again, ſo long as it continues intimately mixed.

It is pretty much in the like manner that the particles of copper, ſilver, and of gold itſelf, the heavieſt of all metals, keep ſuſpended between the parts of *aqua fortis* and *aqua regia* that have diſſolved them.

This theory receives great illuſtration from Mr. Petit's obſervation on the particles of ſalts and metals not ſeparating the particles of air, which we have mentioned pag. 17th and 18th.

The

The reader will obſerve that *as* the abſorbing of air into water is a kind of *precipitation* or a *diſtillation per deſcenſum*, which, in ſpite of the uſual laws of hydroſtatics, is made of a fluid leſs heavy into one which is more heavy; *ſo* the abſorbing of water into air is a kind of *diſtillation per aſcenſum*, in which a liquid more heavy mounts into one that is leſs heavy; the method of the one is only the inverſion of the method of the other.

Hiſtory 1742, *pag.* 18.

An explication of the phenomenon of the tides in the lake of Geneva.

Mr. Addiſon, in his remarks on ſeveral parts of Italy, makes mention of that kind of flowing and ebbing of the lake of Geneva, that is obſerved *there* under the name of *ſeiches*, and thinks he hath diſcovered the true cauſe of it. "In ſummer, ſays he, it "has ſomething like an ebb and flow, which "ariſes from the melting of the ſnows that "fall into it more copiouſly at noon than at "other times of the day."

Upon which ſolution Mr. Jallabert remarks, that the ſhort continuance Mr. Addiſon made at Geneva did not permit him to be thoroughly informed of all the circumſtances of this phenomenon; which is obſerved in the *morning* as well as in the *afternoon*, in *winter* as well as in the *ſummer*, tho' in the former ſeaſon it is leſs frequent. He would have been told likewiſe that it doth

doth not *prevail* through the whole extent of the lake, which however it ought to *do*, if it depended on the waters which the rivers ſwoln by the melting of ſnows poured thither in greater abundance.

Mr. Addiſon doth not explain neither why *ſeveral* ebbs and flows are obſerved in the ſame day, a circumſtance that is very ſingular and well worthy of attention. The water ſwells ſuddenly a foot, ſometimes more, and ſometimes leſs, and ſinks again very ſoon *after* almoſt as ſuddenly: theſe reciprocations of high and low water ſucceed one another ſeveral times in a day, in ſuch manner however that the intervals of time between the *floods* are greater or ſmaller, according as the elevation of the waters is more or leſs conſiderable. Mr. Jallabert hath remarked at Geneva, upon one of the pillars which ſupport the hydraulic machine for raiſing the waters of the Rhone, that when the waters of the lake riſe ſeven or eight inches, the interval between two *floods* is about 14 or 15 minutes, and from 24 to 26 when they riſe a foot.

It is not eaſy to aſſign the cauſe of this phenomenon; ſome perſons have attributed it to ſubterraneous winds, which eſcaping with violence and by ſudden ſtarts, raiſe up the waters of the lake: but if it was owing to this cauſe, the ſwell of the water would be perceived in other places beſides the extremities

tremities of the lake, it would boil up, and bubbles of air would be ſeen to riſe from its ſurface, which Mr. Jallabert hath never obſerved.

Mr. Fatio de Duillier, a learned geometrician, who was perfectly acquainted with the natural hiſtory of the country about the lake of Geneva, and hath written of it [a], attributes this kind of tides to ſtormy winds from the ſouth, which blowing with violence check the waters of the lake, and hinder them from running into the Rhone with the *ſame* abundance, till the wind being ſlackened, or the water having ſurmounted by its weight the effort of the wind, it flows with more freedom, and in greater quantity than before: but how will this explanation tally with the *ſeiches* that happen in calm weather, as hath been often remarked? And how will this ſolve *their* appearance at the ſouthern extremity of the lake, where the city of Geneva is ſituated, and from whence, in going towards the north-eaſt, the lake is confined within a canal of about four leagues in length upon half a league, or at the moſt a league in breadth?

Mr. Jallabert before he propoſes the explication that appears to him the moſt probable, premiſes theſe two remarks:

Firſt, That towards the entrance of the Rhone that opens into the lake, the *ſeiches* are

[a] Vid. Remarques, &c. imprimées à la fin du 2d. vol. de l'hiſtoire de Geneve de Spon.

are obſerved only at Bouveret and Villeneuve, towns ſituated at the extremity of two little gulfs, the one to the left, the other to the right of the mouths of this river. In places more remote from this extremity of the lake, at St. Gingo for example, which is not a league diſtant from Bouveret, and at Vevei, which is not two leagues from Villeneuve, this phenomenon is intirely unknown. At the other extremity towards Geneva, the tides riſe only in that part of the Rhone that is above the confluence of this river and the river Arve, which empties itſelf into the Rhone at leſs than a mile below Geneva, that is to ſay, the *ſeiches* appear manifeſt only *in that part of the lake* and for two or three miles above Geneva.

Secondly, That the *ſeiches* are moſt perceived in *cloſe* weather threatning rain, when the air is very mild; at which times the ſnows melt more copiouſly on the mountains, experience ſhewing that ſuch weather accelerates more the melting of ſnows than a bright ſun-ſhine would *do*.

Having eſtabliſhed theſe facts, Mr. Jallabert enters into the explication of the phenomenon, beginning with the *ſeiches* that are perceived near the entrance of the Rhone.

It is well known that this river takes its ſource at mount *forca*, or the *forked mountain*, which lies at the eaſtern extremity of the country of Valais; and that before it throws itſelf into the lake, it flows between

other mountains of the ſame country, which are always covered with ſnow. In mild weather the ſnow melts, the Rhone ſwells conſiderably, and at ſuch times entering with impetuoſity into the lake, drives the waters of it, to the right and left, into the two little gulfs that are ſituated near the entrance, and at the extremity of which are placed the towns of Villeneuve and Bouveret. The waters *there* at firſt riſe on the ſhore of each ſide, and afterwards ſubſide, in conſequence of their weight *becoming* ſuperior to the action of the waters of the Rhone againſt them, and reſume the level of the reſt of the lake. As the impetuoſity of the Rhone *thus* ſwoln ſubſiſts for a certain time, there muſt reſult from *its* action on the *waters* of the lake, and from *their* re-action, a *flood* and an *ebb*, ſucceeding each other, pretty much like the alternate aſcent and deſcent of a pendulum. The reader by caſting his eyes on a map of the lake, will ſee that the *ſeiches* which are perceivable at this extremity cannot paſs beyound Villeneuve and Bouveret, becauſe the lake from thoſe places acquires almoſt immediately ſo great a breadth that ſuch a ſwell of waters diffuſed on ſo large a ſurface muſt inſtantly become imperceptible.

The like explication will hold for the tides that are obſerved at the other extremity. The river *Arve*, which takes its ſource in the alps of Savoy continually loaded with

ſnow, and which throws itſelf into the Rhone at about a mile below Geneva, cannot fail to *ſwell* conſiderably during the melting of the ſnows. Its waters increaſed, and ſo much the more ſwoln as the channel is more confined, will conſequently ſtop *thoſe* of the Rhone, or make them ſwell; and the *latter*, which compoſe a great part of the waters of the lake in that narrow canal which contains it above Geneva, will produce in their turn a ſwelling of the waters of the lake for two or three miles above that city, or at the moſt as far as Gentou and Bellerive, *where* experience ſhews us that the *ſeiches* of this extremity are terminated. Their ebb or ſinking will be occaſioned in like manner by the action of their own weight, when the waters ſhall have riſen to a certain height, which is commonly about a foot; and this alternate action and re-action of the waters performed in an interval of 15 or 20 minutes, will produce the *floods* and *ebbs* that are the ſubject of our enquiry. In a word the *Arve* being ſwoln produces *in that part* upon the Rhone, and by means of the Rhone upon the waters contiguous to the lake, the ſame effect as the waters of the Rhone and *thoſe* of the lake occaſioned reciprocally the one upon the other at the entrance.

It is evident that all theſe effects will be ſo much the more conſiderable, as the cauſe producing them, according to Mr. Jallabert, ſhall be more diſtinguiſhable and more ſud-

den; and this is what experience juſtifies in favour of his ſolution. When the melting of the ſnows and the fall of rains have been extraordinary, and the ſwell of the *Arve* reaches to or exceeds the height of the ſuperior waters of the lake, theſe waters and thoſe of the Rhone being no longer able to flow together *below* Geneva, are forced to flow back towards the city and towards the lake; and in that caſe *thoſe* of the Rhone return back along the *right* ſuperior and northern ſhore, and *thoſe* of the Arve along the *left* and ſouthern ſhore; the one and the other appearing *diſtinct* by the colour that is peculiar to them, or which they have acquired accidentally. This was obſerved on the 3d of December 1570, on the 21ſt of November 1651, on the 10th of February 1711, on the 15th of September 1733, and on the 21ſt of December 1740, when it was ſeen with ſurpriſe, that the waters of the Rhone carried away, *towards* the lake, the boats and all other bodies that were floating, and cauſed the mill wheels to turn in a contrary direction.

It might be alledged againſt the hypotheſis of Mr. Jallabert, that the *ſeiches* have been ſometimes perceived near Geneva at a time when the waters of the Arve have been *low*: but beſides that theſe caſes are very rare, and that the *ſeiches* then are ſcarcely perceivable; they never happen but when the waters of the

the Rhone are very *low* likewiſe, and are always preceded by a warm wind, which diſſolves the ſnows in a ſufficient quantity to ſwell the Arve that was *before* extremely *low*. Of this kind Mr. Jallabert obſerved one in the beginning of April 1742, which roſe ſeven or eight inches. A ſouth-weſt wind, that continued 24 hours, cauſed the thermometer of Mr. De Reaumur to riſe, from the ſixth degree above 0, which anſwers to freezing, as high as the thirteenth. As the lake doth not begin to increaſe till the month of May after the melting of the ſnows, the Rhone is commonly very *low* in the month of April, and it was *ſo* in reality when the *ſeiches* of which we have been ſpeaking were obſerved.

Mr. Addiſon was right *in general* in ſaying that this kind of ebb and flow was occaſioned by the melting of the ſnows; but *that* amounts only to a vague conjecture, which leaves the phenomenon undetermined, and ſeems even oppoſite to it in certain reſpects. One makes no acquiſition in phyſics without entering, as Mr. Jallabert hath *here* done, into an exact and rational detail of facts and circumſtances.

Hiſtory 1742, *pag.* 26.

I muſt do Mr. Addiſon the juſtice to obſerve, that though he barely mentions the melting of the ſnows as the cauſe of the ebb and flow in

the lake of Geneva, yet he is more ample in aſſigning the ſame cauſe for the riſe of the periodical fountains in Switzerland. "I fancied, ſays he, the confuſion of mountains "and hollows, I here obſerved, furniſhed "me with a more probable reaſon than any "I have met with for thoſe periodical fountains, which flow only at ſuch particular "hours of the day. For as the tops of "theſe mountains caſt their ſhadows upon "one another, they hinder the ſun's ſhining "on ſeveral parts at ſuch certain times, ſo "that there are ſeveral heaps of ſnow which "have the ſun lying upon them two or three "hours together, and are in the ſhade all "the day afterwards. If therefore it happens that any particular fountain takes its "riſe from any of theſe reſervoirs of ſnow, "it will naturally begin to flow on ſuch "hours of the day as the ſnow begins to "melt; but as ſoon as the ſun leaves it "again to freeze and harden, the fountain "dries up, and receives no more ſupplies "till about the ſame time the next day, "when the heat of the ſun again ſets the "ſnows a running, that fall into the ſame "little conduits, traces, and canals, and by "conſequence break out and diſcover themſelves always in the ſame place."

Of the ſpaying of fiſh.

Sir Hans Sloane hath written to Mr. Geoffroy an account of a man's having been with him, to whom he was a perfect ſtranger, in order

order to communicate the ſecret he had found of ſpaying fiſh, and fattening them by that means. The man, who at firſt was only a net-maker, and lived about fifteen miles from Sir Hans's country-houſe, having acquired great ſkill in the breeding of fiſh, had gained a conſiderable profit from it. The ſingularity of the fact excited the curioſity of the learned naturaliſt, and the fiſh merchant offered to make trial of it before him. Having fetched eight *carruchens*, a kind of ſmall carp that have been lately imported into England from Hamburg, which he had put into two large veſſels filled with water, and had given freſh water twice or thrice upon the road, he diſſected one of the eight carps immediately in the preſence of Sir Hans, and ſhewed him the ovary, together with the paſſage which leads into the *part* that is called the cloaca. Upon another of *them* he performed the operation of ſpaying, by opening the ovary, and ſtuffing into the wound a piece of a black hat. The carp that had been ſpayed being put with the other ſix that remained, appeared to ſwim with ſomewhat leſs eaſe than the others; afterwards they were all thrown into the *baſon* in Sir Hans's garden, the water of which is ſupplied by the neighbouring river, and *where* he believed them ſtill living when he wrote to Mr. Geoffroy. We have not yet received any further account: the letter was ſent towards the end of laſt De-

cember; and Samuel Tull, which is the man's name, promiſed Sir Hans to ſend him, in the following ſpring, ſome of theſe ſpayed fiſh, which he ſays exceed the others in delicacy of taſte, as much as a poularde ſurpaſſes a cock, or a fat ox a bull. This effect of the ſpaying of fiſh, is very probable from its analogy with what happens to land animals: and Sir Hans thinks that ſuch a diſcovery deſerves to be purſued, and may be uſeful, both for making the fiſh more fat and delicate, and for diminiſhing their multiplying in ponds and ſtagnating waters, that abound too much with young fry, which prevents their growth.

Hiſtory 1742, *pag.* 31.

Obſervations on Mr. Hales his account of the freezing of rivers, by the abbé Nollet.

The concurrent teſtimony of millers, watermen, and fiſhermen, confirmed by the authority of Dr. Plot in his hiſtory of Oxfordſhire, determined Mr. Hales to examine into the truth of an aſſertion, "that rivers are "found conſtantly to freeze firſt at their "bottoms." In the appendix to the ſecond volume of his ſtatical eſſays, we find that he went two years ſucceſſively to the Thames when it was frozen, cauſed the ice to be broke, and obſerved the river as well at the bottom as on the ſurface. Theſe are his words: "The ſurface of the water was "frozen about one-fifth of an inch thick," *(the abbé Nollet by miſtake tranſlates it one-third)* "under which ice, I ſaw at the bottom

" tom another bed of ice; then breaking " away ſome of the upper ice with a pad- " dle, I took up ſome of the lower ice, " which was about half an inch thick, but " was not ſo ſolid as the ſurface ice, but " more ſpongy and cavernous. This lower " ice joined to the upper ice at the brink of " the water, and was gradually more and " more diſtant from it, as the bottom deep- " ened; for it adhered cloſe to the bottom, " where the ſtones and ſand were incorpo- " rated into it, and which it brings up to the " ſurface along with it." *Pag.* 356.

Nothing can be ſaid more poſitive in favour of the vulgar opinion; it is the teſtimony of a ſkilful experimental philoſopher, who pronounces from appearances that have not at all the air of equivocation: yet as deciſive as they ſeem, if Mr. Hales judged the ice to be adherent to the bottom for this reaſon only, becauſe it was mixed with ſand and ſtones which it brought up to the ſurface of the river, it will be ſeen, in the courſe of this memoir, that his judgment was not ſo well founded as at firſt view one would be inclined to think. To diſſipate, or rather to have prevented all doubt, I could wiſh that Mr. Hales had ſaid poſitively that he had cauſed the bottom of the river to be ſounded in his preſence *at ſome diſtance from the ſhore*, and that *there* he had found ice adherent in ſeveral places. But in reading the context from whence

whence I have made the citation, it is manifeſt that the obſervations were made in a bay at the watering place at *Teddington*, which conſequently had but little depth of water at the edges; that the ice was no more than $\frac{1}{5}$th of an inch thick, which could not permit the obſerver to advance any further; and the teſtimony of fiſhermen is ſo often appealed to, that there is reaſon to fear Mr. Hales hath too eaſily placed his confidence in *them*. However *that* may be, I am going to relate what I have *done* and what I have *ſeen*, in order that the reader may perceive what may very probably have impoſed on *thoſe*, who think they have proofs of the congelation of water at the bottom of rivers.

This winter when the *Seine* was bound by the froſt, the thermometer of Mr. De Reaumur being 10 degrees below the freezing point, I cauſed the ice to be cut three or four feet from the border, and detached from it a piece about a foot ſquare, that was eight inches thick. When I took it I perceived that the *under* part was not ſmooth as it commonly is in ice that is formed from a ſtagnating water, neither was it compact like the reſt, but very uneven, and as it were ſpungy, having all the appearance of a lay of ice rugged and grumous faſtened *underneath* to a flake more ſolid and uniform; I always perceived the ſame thing to happen in every part of the river, where I cauſed pieces

of

of ice to be taken: I remarked likewiſe that at the bottom of the holes which I had made in the ice in order to get the pieces I have been ſpeaking of, inſtead of ſeeing a clear water, as it commonly is when one makes a hole in the ice of a baſon or a veſſel, I ſaw nothing but little parcels of ice not well united, and intirely like *the lay* I had ſeen *under* the flake of ice I mentioned before; I cauſed a certain quantity of theſe little parcels to be taken up, but notwithſtanding all the care I took to make the water clear I could never ſucceed in it, this ſort of ice was continually renewed on the ſurface: and the workmen I employed, finding my deſign, aſſured me on the experience they had often had, that I took an uſeleſs labour. I was obliged to believe them with regard to the fact, but was not perſuaded of the reaſons they gave me for it. "This ice, ſaid they, which we take "up at this hole is the [b] ragged ſoft part of "ice that is formed in the night at the bot-"tom of the river, and which the ſun draws "up in the day to the ſurface; you may "obſerve, added they, that almoſt all the "pieces we take up, are dirty, full of earth, "and ſometimes contain blades of graſs."

Of all I heard them ſay, there was but one thing that appeared worthy of my attention, *namely*, the *dirtineſs* of the *bouzin*, as they called it, which I found to be *real*, and attributed

[b] Bouzin in French, Mr. Hales calls it the ice-meers.

tributed at firſt to the nearneſs of the ſhore, and to the little depth of the river in thoſe places where I cauſed the ice to be opened; this notion had a probability, but ſoon loſt it by an experiment that ſeemed likely to confirm it. I made *them* open the ice in places where the river was nine or ten feet deep, and when the piece of ice was lifted up I ſaw, contrary to my expectation, that the ragged ſoft part (bouzin) reſembled very often *that* which I had obſerved nearer to the ſhore, that it contained in like manner filth, and that the ſurface of the water was always covered with it, whatever pains I took to remove it.

I could no longer therefore conſider this *bouzin* as an ice formed near a ſandy bottom, that is ſtirred by the agitation of the water. But muſt I conclude, contrary to all principles, that the ice which appears on the ſurface of a river, thickens only by the addition of parts frozen at the bottom? If the *freezing* of rivers is not conformable to *that* of ponds and baſons, can the difference that is obſerved have any other cauſe than the motion of the water, and can that motion occaſion the cold to ſeize the bottom before the ſurface? Mr. Hales in order to explain this phenomenon which he conſiders as certain, pretends that the bottom may acquire a ſufficient degree of coldneſs to freeze the water, becauſe it flows *there* more gently than elſewhere,

elſewhere, *the upper water*, ſays he, *being in a greater degree of motion than the lower, it cannot ſo ſoon freeze*: but I cannot yield to the ſuppoſition itſelf that the water freezes ſooneſt at the bottom; for having ſeveral times, and in different years plunged thermometers to all ſorts of depths in the river, when the ice of the ſurface was two, three, ſix, and even eight inches thick, I never found the water to be at the degree of cold that is neceſſary for freezing. Indeed it ſometimes comes very near it, but even *that* is only after ſeveral days of hard freezing, and not when the ice of the ſurface is no more than three quarters of an inch thick; in a word, I always found that water actually fluid had never the coldneſs of ice; how then ſhould it be able to tranſmit that coldneſs to the bottom over which it flows?

Altho' theſe experiments prevent my believing with Mr. Hales that rivers freeze at the bottom, yet it muſt be owned that we commonly find under the ſolid ice of the ſurface of rivers that other ſort of ſpongy ice which I have mentioned, that it is often earthy and full of ſand, and that theſe marks are found in it not only when it is taken up near the ſhore, but likewiſe in *places* where the river is nine or ten feet deep. We ſhall now endeavour to ſhew that theſe facts, tho' rightly obſerved, have not been explained as they ought, and that they may be reconciled with

with the uſual effects of freezing and with the notions we have of it in phyſics.

The difficulty of exhauſting the *bouzin* or *ice-meers* by the holes that had been made in the ice, induced me to think that it followed the current of the water 'till ſome circumſtance determined it to fix beneath the ſolid flakes of ice; if my conjecture was right, there could be *none* but on the ſurface of the water, and if ſome obſtacle was interpoſed to hinder it from following the ſtream of the current, there ſhould no longer appear any at the place immediately below the obſtacle. A large wooden ſhovel which I plunged perpendicularly ſhewed me enough to give me a good opinion of my conjecture; but as what paſſed by the ſides did not permit me to have the ſurface of the water intirely clear, I ſent for a caſk, and having knocked out the two ends I let it down through a hole made in the ice of a ſuitable bigneſs to $\frac{3}{4}$ths of its length; by this means I formed a kind of well, from which I exhauſted the ice-meers in a very little time, and was convinced that this ſort of ice was carried by the current, and doth not commonly fix in the place where the freezing produced it.

To this experiment may be joined an obſervation I am going to mention, which alone would be ſufficient in my opinion to undeceive thoſe who think that ice ariſes from the bottom of the water. If it was true that it

roſe

roſe from thence, ought not the filth that is obſerved in it to be of the ſame kind as the bottom on which it is pretended to be formed? Yet I have obſerved the direct contrary, moſt commonly the ice-meers appeared yellow or full of ſand, whilſt the bottom of the river, which I cauſed to be ſounded, was only mud for conſiderable diſtances. Theſe ice-meers therefore muſt have come from ſome diſtant ſuperior part, and if *this* be admitted, it is not difficult to explain why they ſhould be dirty, earthy, and ſometimes full of graſs and ſtraws, altho' not formed upon the ground; it is ſufficient (and the ſuppoſition will eaſily be allowed) that they have trailed on the bottom in places where the river is low, and that the little cluſters which compoſe them were dirtied before they united.

The reader will ſee by what I have been mentioning, that the vulgar opinion on the pretended formation of ice at the bottom of rivers hath ſome appearance of reaſon; but will perceive likewiſe that theſe appearances have nothing real when examined with care. It remains now to know why theſe deceitful appearances, theſe aſſemblages of frozen cluſters, which we have named *bouzin* or ice-meers, and that cover the under part of ſolid flakes of ice, are found only in waters that have a current; for it is a certain fact that this ſort of ice is never found in ſtagnating

ting waters. How *then* is it formed, and what determines it to occupy the places it uſually affects?

Ice, as is well known, is water that hath loſt its fluidity, or in other words, whoſe parts or *moleculæ* are fixed in *certain* poſitions relative one to another, and faſtened *together* in the manner of ſolid bodies; the cauſe of this fixation is cold; but the cold operates this effect quicker or ſlower, according as it acts on parts that have more or leſs motion; for which reaſon pools, baſons, ponds are commonly bound up before rivers, and the *latter* begin always with freezing at the edges, becauſe the water *there* is leſs agitated.

The motion, which retards or hinders the effects of froſt, is not the motion that the parts of water have *in common*, but rather *that* which they have each *in particular*. If the middle of the river, which is commonly called the *current*, doth not freeze as well as the edges, it is not becauſe the water *flows* in that part, it is not *even* becauſe it flows *there* more *ſwift* than elſewhere; but becauſe it flows *by waves*[c], and that all its parts have

[c] *Or in the expreſſion of Horace, which gives a more lively image,*

——— LABORAT
Lympha fugax TREPIDARE rivo,

where ſome of the commentators have abſurdly interpreted the word trepidare, to murmur; but that ſenſe may be confuted from Horace himſelf, Epiſt. lib. I. *Epiſt.* X. *ver.* 20.

Purior in vicis aqua tendit rumpere plumbum,
Quam quæ per pronum *trepidat cum murmure* rivum?

According

have not an equal ſwiftneſs; for if it was poſſible that in their common motion they could keep the ſame reſpective poſitions to each other, I ſee no reaſon, which on ſuch a ſuppoſition ſhould hinder the cold from fixing them, and turning them into ice. This concluſion is not only probable but juſtified in all appearance by fact, for I think I am able to prove that the large pieces of ice one ſees floating down a river, were formed *chiefly* of a water that hath not ceaſed to move, and ought not to be conſidered, at leaſt for the greateſt part, as fragments detached from the ſides, or deſcending from the little rivers where care hath been taken to break the ice, as ſome naturaliſts have thought. This notion cannot ſupport itſelf, if a due attention be paid to the following obſervations; that an *increaſe* of cold which renders the ice of the edges more ſolid, and conſequently leſs liable to break, always *multiplies* the ice that is carried down the ſtream of the water, unleſs the froſt increaſes to a certain degree of ſeverity that produces a quite contrary effect; that the floating pieces of ice are *as many*, or even

According to the interpretation I have juſt mentioned by thoſe learned gentlemen it follows, that the expreſſion trepidat cum murmure *is the ſame in ſignification as* murmurat cum murmure; *Riſum teneatis? Or indeed it ſhould rather excite a different emotion, ſince commentators are too generally confided in,* to ſee *ſuch an elegant writer ſo miſerably mangled.*

To me the expreſſion laborat trepidare *conveys a very lively image of the manner in which a ſtream works its way with a kind of quivering motion.*

even *more* numerous in the morning than in the evening; is it probable that people have been at work in breaking off the pieces of ice in the night time? Or if they come from ſuch a diſtance that they may be ſuppoſed to ſet out the preceding day, how comes it to paſs that the greateſt number have not been ſtopped on the way either by the ice of the borders, or by a thouſand other obſtacles that are to be met with on a river half frozen? Moreover, if they have been detached by dint of labour, *what toil* muſt be ſuppoſed in order to produce ſo great a quantity, and how is it known that the country people *act thus* by concert, to diſengage the rivers? Laſtly, if *theſe* pieces of ice are compared never ſo little *with thoſe* that are faſtened to the ſhore, what differences may be diſcerned in them? The *latter* are almoſt always ſmoother, thicker, harder, and more tranſparent; the *former* therefore are not made of the ſame ſtuff, as I may ſay, but the manner of their formation I ſhall now explain.

If you caſt your eyes on a large river, particularly in the country and in calm weather, you may obſerve abundance of places where the ſurface of the water flows in a manner *ſerenely ſmooth*, where the parts by conſequence have only a velocity that is common to *all*, and are at reſt reſpectively to each other: let us ſuppoſe ſuch a *gliding* motion to continue ſome inſtants during a ſevere froſt, there

there will be formed a piece of ice more or leſs big according to the *extent* of the *uniformity* of motion we have ſuppoſed, or *that equality* of velocity; which however we would not be underſtood to mean ſtrictly *ſuch*, but moſt commonly *ſufficient* to give room for freezing.

If this firſt piece of ice, yet tender and thin, floats *ſome time* upon a water that continues to flow in that manner, far from breaking, it hardens more and increaſes in thickneſs, becauſe the degree of cold it hath increaſing more and more, its parts are condenſed, and it becomes *itſelf* capable of freezing the water that *immediately* touches it; and even tho' it ſhould paſs afterwards into places where the current is *wavy*, or ſhould knock againſt other ice, its hardneſs and dimenſions may be ſuch as to reſiſt the *undulatory* motion and the knocks; or if it ſhould chance to break, the pieces may ſtill continue big enough to compoſe *another* by their union with *like* fragments.

But on the contrary, if *that* firſt ice, at the moment it begins, paſſes to a part of the river too much agitated (which without doubt is the moſt uſual caſe) or happens to be preſſed between two more ſolid pieces of ice, it is cruſhed, and reduced into very ſmall parts that float where the waves carry them; and which moſt commonly do not join *together* again, or, if they join, they form only

little clusters: now these little pieces of ice formed on the whole surface of the water, but principally towards the edges, being loaded with all the particles of *foreign* matter that they at first associated, or have met with in their passage, such as *earth*, *mud*, *foam*, *straw*, bits of *grass*, &c. occasion *sometimes* that sponginess which is observed, and at *other times* that rough and grumous surface, which hath been thought the *print* of the soil from whence they rose.

Memoirs 1743, *pag.* 52.

A new discovery in optics.

Mr. De Buffon hath discovered that the *shadows* of bodies, which from their essence ought to be *black*, since *they* are only a privation of light, are always *coloured* at the rising and setting of the sun. I have observed, says he, in the course of this summer more than thirty rising and setting suns, all the shadows that fell upon *white*, as upon a white wall or white paper, were sometimes green, but most commonly blue, and of a blue as lively as the most beautiful azure. I have shewn this phenomenon to several persons who have been *equally* surprised at it. The season of the year makes no alteration. I do not know that any astronomer, natural philosopher, in a word, any one hath taken notice of this phenomenon before.

Memoirs 1743, *pag.* 157.

Mr.

Mr. Bouguer was willing to try what would be the effect of the heat of the ſun in the torrid zone on metals, and the experiments he made diſcovered to him a fact that he probably would not have conjectured; *namely*, that the heat of the ſun to which we can be expoſed without any danger, occaſions in metals an *extenſion* more conſiderable than *what* is occaſioned by boiling water, altho' boiling water is capable of deſtroying in an inſtant the organiſation of an animal body: the reaſon probably is, that the particles of fire which are mixed with the boiling water are retained *there*, and cannot inſinuate themſelves in a ſufficient quantity into the cloſe *pores* of iron, *that* are more adapted and proportioned to the particles of light; but the lax ſoftneſs of fleſh gives the particles of fire a free paſſage, by which they enter and diſſolve the texture; whilſt the ſolar matter, paſſing perhaps too eaſily, cannot produce that effect.

An obſervation of the different effects of the heat of the ſun on metals and animal bodies.

Hiſtory 1745, *pag.* 12.

I add in confirmation of the preceding remark, that it is very certain that the ſolar matter or particles of light are much finer and more ſubtil than thoſe of fire; gold that is invincibly fixed in the moſt intenſe fires, becomes volatile in the heat of the ſun by means of a burning glaſs, which deſtroys its very eſſence. Nothing haſtens putrefaction of animal ſub-

ſtances ſo much as hot vapours, perhaps becauſe the moiſture relaxes more the pores, and gives an eaſier admiſſion to the particles of fire.

The conformity between electrical matter and elementary fire, by the abbé Nollet.

What is that matter which is commonly called *electrical matter*, and is with reaſon conſidered as the principal agent in the phenomena which we are ſolicitous to ſolve? from whence comes it? how is it put in action? and by what mechaniſm doth it produce thoſe ſingular effects that we admire? Theſe are the objects of my preſent inquiry.

In order to anſwer the *firſt* of theſe queſtions, I ſearch in nature for ſome ſubtile *known* fluid, or at leaſt *ſuppoſed* and *admitted* by the greateſt number of natural philoſophers, a fluid that hath *characters* reſembling *thoſe* of the matter which cauſes electricity, that is capable of *burning* and *giving light*, that can produce however ſometimes the *one* without the *other*, that *diſcharges itſelf with a noiſe* according to certain circumſtances, that affects our organs of *feeling* and *ſmelling*, if not by itſelf, at leaſt by means of the ſubſtances with which it aſſociates; for if I can find ſuch a fluid that uſually diſcovers itſelf by *ſuch* effects, may I not with reaſon attribute to it *theſe ſame* effects wherever I ſhall meet with them?

Now *theſe* are the *characters* of fire properly ſo called, of that element which is ſuppoſed with the utmoſt reaſon to be everywhere preſent, not only *within* fluid mediums

and

and *round* ſolid bodies, but even within their inmoſt receſſes and in the pores of their integral parts. Let us take a view of its moſt known properties, and compare them with *thoſe* of the matter which makes electricity.

In the firſt place, the elementary fire doth not act of itſelf and without being excited, the bodies which contain the moſt of it, or which have the moſt diſpoſition to yield to its action, ſuch as oils, ſpirits and vapours that are called inflammable, certain torrified or calcined ſubſtances, the phoſphori, do not burn of themſelves, or diſcover more heat than other bodies in the ſame place, unleſs ſome particular cauſe lets looſe or excites the principle of inflammation that is within them; now of all the means proper to animate this principle, there is none more efficacious or more ſudden than *that* which gives the firſt riſe to electricity; bodies become *electrical* in the ſame manner as they are made *hot*; by rubbing them you produce the *one* and the *other*; they may be *electriſed* by communication, as one body may *catch fire* from another that is on fire before; but in both caſes it is neceſſary that the body, from which thoſe qualities are originally derived, ſhould be rubbed; thus for inſtance, the flame that now conſumes my candle was ſtruck at firſt from the flint and ſteel.

Secondly, when a body is rubbed in order to excite heat, the heat commonly is

produced ſooner, and becomes greater in proportion as the body is denſer, and its parts more elaſtic; all metals grow hot under the file and hammer, but iron becomes burning hot, becauſe it hath more elaſticity than the others. A cutler's grind-ſtone makes a blade of an *hard-tempered* ſteel to throw out ſparks of fire every way, but if it is of a *ſoft* iron you ſee no ſuch effect; the [a] Indians get fire for the common neceſſaries of life by rubbing one againſt another two pieces of a ſort of wood that is very hard, Whereas it is by accident only and after violent and long continued motions,

——Metaque *fervidis*
Evitata rotis,

that our common woods, which are much ſofter, acquire ſuch an heat as to catch fire.

In the like manner it may be obſerved that bodies capable of becoming electrical by rubbing, acquire that ſtate ſo much the ſooner and in a more eminent degree, as their parts are ſtiffer and more proper for a lively reaction; white wax, for example, which becomes a little *electrical* during a hard froſt, is not *ſo* at all when tried in warm weather or in a hot place; Spaniſh wax, or the gum lacca of which it is made, becomes more electrical than the former at all ſeaſons, but

[a] Mr. De la Condamine mentioned that for a long tract of country along the courſe of the Amazon they know not what a ſtone is.

but is never ſo electrical as ſulphur and amber, that may be rubbed more ſtrongly and for a longer continuance without their parts becoming ſoft and loſing their elaſticity. Is it not on account of the reaſon juſt mentioned that glaſs rubbed becomes more electrical than any other ſubſtance we know of?

Thirdly, The action of fire ſeems to extend itſelf more and with greater eaſe in metals than in any other kind of ſolid bodies; if you hold by one end a rod of iron, copper, ſilver, *&c.* of a moderate length, whilſt the other extremity touches the fire, the heat is ſoon communicated to the hand; but you do not find the ſame thing to happen with a rule of wood, the ſtem of a pipe, a block of marble or ſtone: I do not ſtop to enquire into the reaſon of this difference, I obſerve only that electricity, like heat, extends itſelf eaſily through metals, and every thing that is compoſed of metal; if I electriſe for example a *bar of metal*, and at the ſame time with the ſame care any other body whatever, either of *the vegetable or mineral kingdom* that is not metalline, I never find ſo much electricity in the *latter* as in the *former*.

Fourthly, Fire that finds no obſtacle, that is free from all foreign matter (it muſt be obſerved that I mean elementary fire, and that I except thoſe caſes where its rays are condenſed by reflexion, refraction, or by any other way); fire, I ſay, that yields to the leaſt

leaſt degree of motion impreſſed on it, is diſſipated without any ſenſible heat, and produces nothing more than light; but if its effort is retarded and it finds oppoſition,

Æſtuat ut clauſis rapidus fornacibus ignis,

it increaſes more and more by *the conſtraint* that continues to animate it; and if it breaks thro' the confinement, like a bomb that ſplits, it *arms* itſelf, as I may ſay, with the parts of matter it hath divided, knocks with violence the bodies that are expoſed to its ſhocks, and through which it would have paſſed quietly and without effect if it had continued in its elementary ſtate. This principle is proved by an infinite number of very common phenomena, and it will be ſufficient to cite two or three of them.

Spirit of wine with which you have wetted a finger *lights* inſtantly by approaching the finger to a wax-candle, but you ſcarce feel the flame: if the ſame experiment be made with ſome heavy oil or any greaſy ſubſtance, it would kindle ſlower or with more difficulty, but the fire would make itſelf the more felt in proportion as it had more labour to break the bonds that held it; fire that ſets ſtraw in a ſudden blaze hath not the ſame heat as if it burned new wood: of whatever kind the aliment of *fire* is, *its* activity increaſes according to the denſity or elaſticity of the circumambient air, that oppoſes its expanſion;

panſion: laſtly, the fire that evaporates of itſelf from the ſurface of the urinary phoſphorus is only light, but the internal fire that is excited by rubbing the ſame phoſphorus becomes preſently a real conflagration.

By adopting the ſame principle with regard to electricity, I find facts that ſeem to juſtify the application. If I electriſe either by rubbing or by communication a glaſs veſſel exhauſted of air, and by conſequence clear from vapours with which that fluid is always loaded, I perceive nothing in the inſide but flaſhes of light ſuch as one ſees in exceſſive hot weather in a ſerene ſummer evening; but if this ſame veſſel continues full of air whilſt it is rubbed, its electricity diſcovers itſelf outwardly, and the light it produces are ſparkles that burn and ſnap: in the firſt caſe the veſſel being purged of air contains only an elementary fire, purified almoſt from all foreign matter, this fluid at the leaſt motion communicated to it *kindles* without effort and without any other effect than that of ſhining in the dark; whereas in the ſecond caſe the electrical emanations find a difficulty in paſſing through the veſſel that is full of a more reſiſting matter, their effort is retarded, they inflame the little portions of matter that invelop them, and *break* into glittering ſparkles.

Fifthly, The matter of fire in executing the function of light moves commonly more freely

freely in a denſe body than in a rarer medium; at leaſt this is a [b] conſequence that hath been thought deducible from the laws it is obſerved to follow in its refractions, *namely*, "that refraction out of a rarer medium into "a denſer, is made *towards the perpendicular*, "and *from the perpendicular* when a ray paſ- "ſes out of a denſer into a rarer medium."

The electrical matter in like manner appears to affect to move *as long* and *as far* as poſſible in the ſolid body that is electriſed, it iſſues more by the *extremities* and *ſaliant* angles than any where elſe, it is *there* it manifeſts itſelf moſt, as is eaſily ſeen by the luminous emanations: this law is ſo conſtant and invariable, that if the body *electriſed* be a veſſel full of water that *runs out*, the beginning of that efflux being then a kind of prolongation of the part, the electricity ſhews itſelf *there* in two manners very remarkable; in the firſt place, it makes the liquor luminous, even tho' it is only common water; ſecondly, it haſtens the *running* in ſuch manner that what fell *before* drop by drop becomes a continued ſtream, and divides itſelf into ſeveral little ſpouts diverging from each other. Mr. Boze relates in a letter ſent to Mr. De Reaumur, that the blood of a man, who had a vein opened, iſſued much faſter whilſt

[b] *See this conſequence treated of at large in the hiſtory and memoirs for* 1723, *by Mr. De Mairan; and for* 1744, *by Mr. De Maupertuis.*

whilſt he was electriſed; and that the drops appeared luminous like fire.

Sixthly, *Light* is transferred in an inſtant to great diſtances, whether it comes directly from its ſource, or is reflected or refracted: experience ſhews us likewiſe that *electricity* runs through a ſpace of 1200 feet by means of a ſtretched cord in the twinkling of an eye[c].

I ſhall ingenuouſly own however that there is a conſiderable difference between the *propagation* of light and *that* of the electrical matter; light is propagated always in a *ſtraight line*, whereas electricity complies with the *bendings* and *windings* of a twiſted body; but I would not be underſtood to mean that the *motion* of the electrical matter is *modified* exactly like *that* which is peculiar to light, I think on the contrary that electricity is propagated, in ſome meaſure *like heat*, in all ſorts of directions.

Seventhly, Electricity, like fire, hath never more vigour than during a froſt, when the air is dry and very denſe; on the contrary, during great heats, or in moiſt weather, it rarely happens that theſe ſorts of experiments ſucceed well: moiſture is injurious with regard to *the bodies* you would electriſe *by friction*, but with regard to *thoſe* you would only *communicate* electricity to, a wetted cord tranſmits

[c] *There are ſome very curious experiments on the inſtantaneous propagation of the electrical matter by the ingenious Mr. Watſon in the philoſophical tranſactions*, N° 485.

tranſmits extremely well that virtue, and even water as I mentioned above becomes electrical. Now *here* again I perceive a certain analogy with fire; for the *kindling* of a fire, in like manner as electricity, doth not take place in *materials* that are very wet; but if the fire hath been kindled in ſome other body, the heat which is the effect of it is eaſily communicated to *them*.

From all theſe properties compared I conclude therefore that it appears to me extremely probable that fire and electricity ariſe from the ſame principle; that the ſame matter, according to certain circumſtances and agitated in a certain manner, makes us perceive heat, gives us light, and drives bodies that are not electrical towards thoſe that are *ſo*.

It will be ſaid perhaps that the *electrical matter*, if it is the ſame as *that of fire*, ſhould be burning or at leaſt hot, whereas the ſparklings it forms give only a pricking ſenſation at the moſt, and when it ſhews itſelf under the form of luminous tufts, it gives no other feeling than of a ſlight puff that ſeems rather cool than hot.

But is it not well known that the ideas of *heat* and *cold* are relative to our ſenſes? Is it not known likewiſe that the lighteſt ſubſtances and the moſt rarefied catch fire the moſt eaſily, that is to ſay, that they are *inflamed* by a degree of heat which would ſcarce ſuffice to give any ſenſible heat to a body that is denſer?

denſer? Do we not bear without any uneaſineſs the ſpirit of wine *inflamed* on the tip of a finger?

Memoirs 1745, *pag.* 113.

I cannot help obſerving as a thing extremely remarkable, that the appearance of the luminous tufts (aigrettes lumineuſes *as the abbé Nollet calls them) is exactly deſcribed by Virgil, whom my old maſter Boerhaave uſed commonly to ſtile a conſummate philoſopher and phyſician as well as a poet.*

Ecce *levis* ſummo de vertice viſus Iuli
Fundere lumen *apex*, tactuq; *innoxia* molli
Lambere flamma comas, et circum tempora paſci.

Æneid. lib. ii. 682.

[a] *Mr. Du Fay was the firſt I believe that gave ſubſtance and reality to elementary fire by applying that term to electricity: we have now a determinate idea, and our ſenſes convey to us the notice of ſomething that may juſtly enough be called elementary fire, ſince it reſembles fire in ſuch a number of particulars: the late Promethean art of ſtealing fire from the clouds, and the unhappy fate of a foreign profeſſor, are I think a ſufficient evidence of the conformity of electrical matter and elementary fire.*

I

[a] Vid. Memoirs 1734, pag. 520.

I cannot conclude without mentioning with honour the glorious ardour for ſcience that the abbé Nollet ſhewed in taking a journey into Italy on purpoſe to ſee the experiments of ſome Italian philoſophers, who pretended to convey the virtues and effects of medicines by means of electricity: an account of the experiments and the diſappointment he met with he ſent in a letter to the late duke of Richmond, which was communicated to the Royal Society and is publiſhed in their tranſactions.

End of the FIRST VOLUME.

Fig. 1.

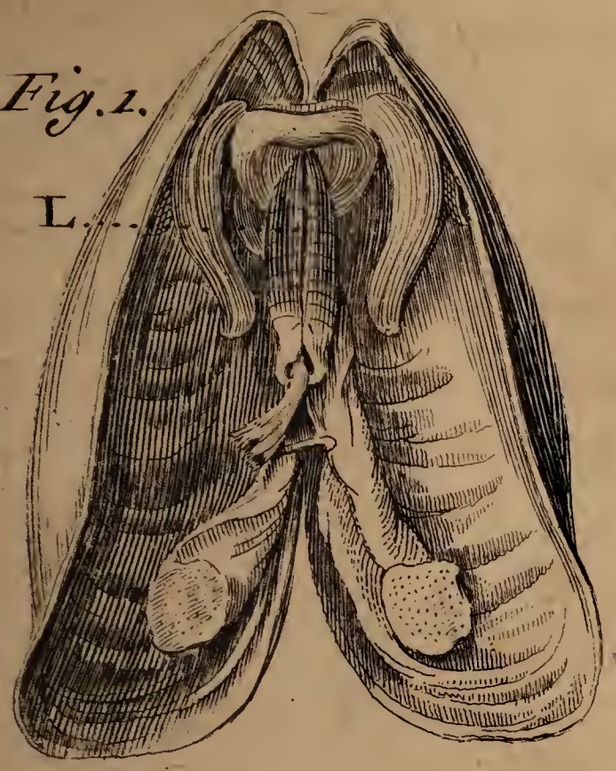


Fig. 2.

Fig. 3.

Fig. 4.

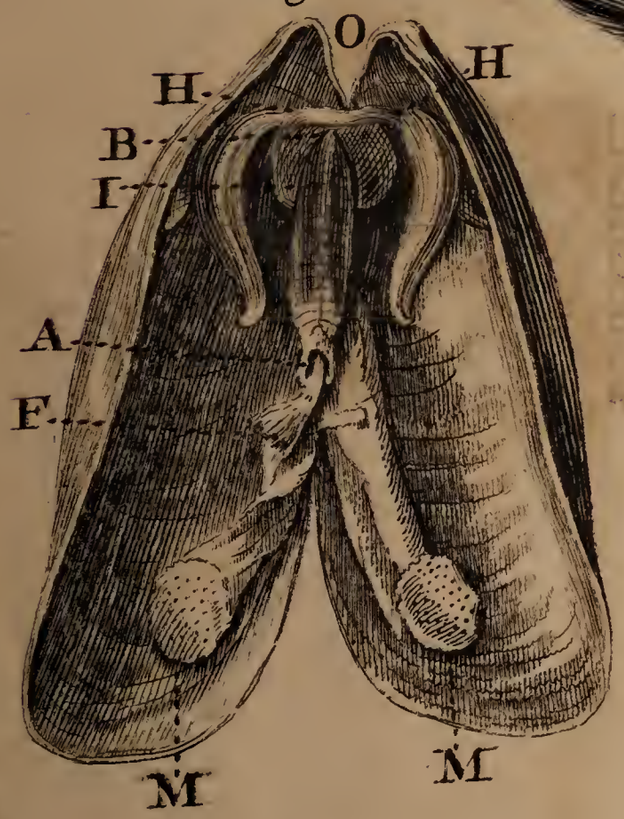
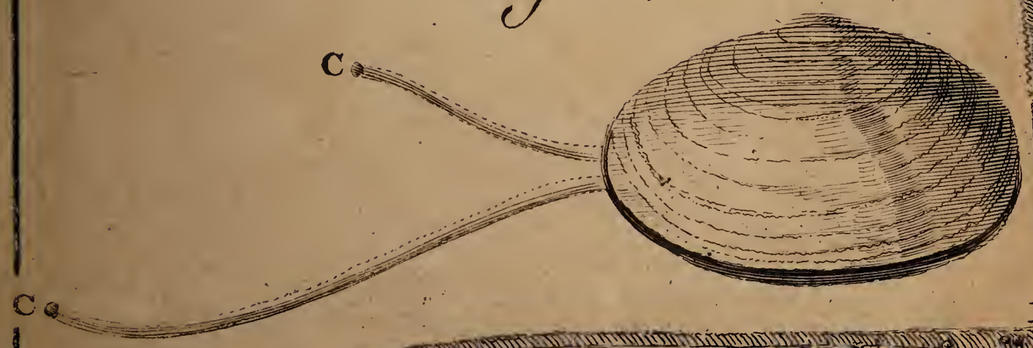


Fig. 5.

J. Mynde sc.

Fig. 1.



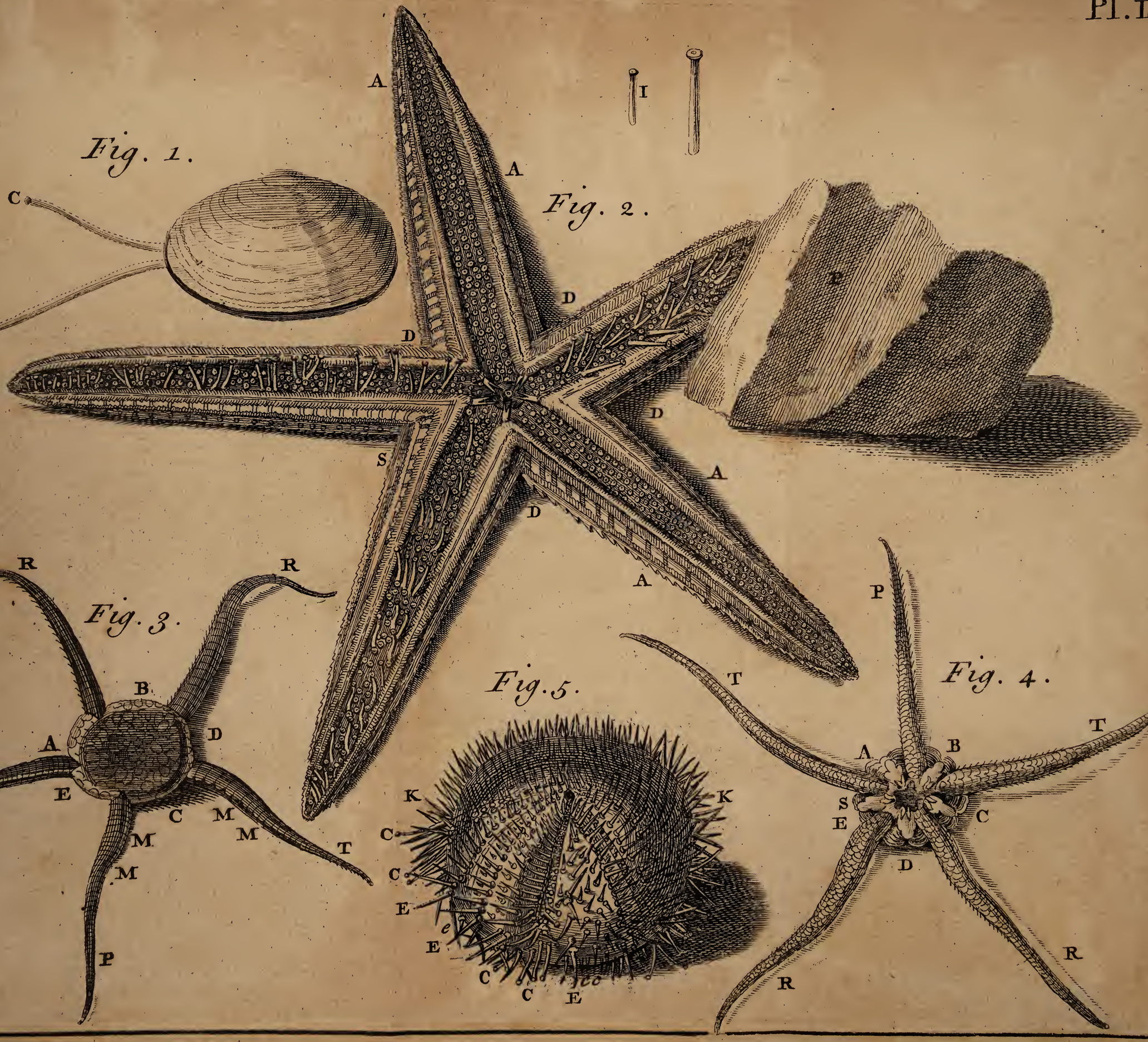


Fig. 2.

Fig. 3.

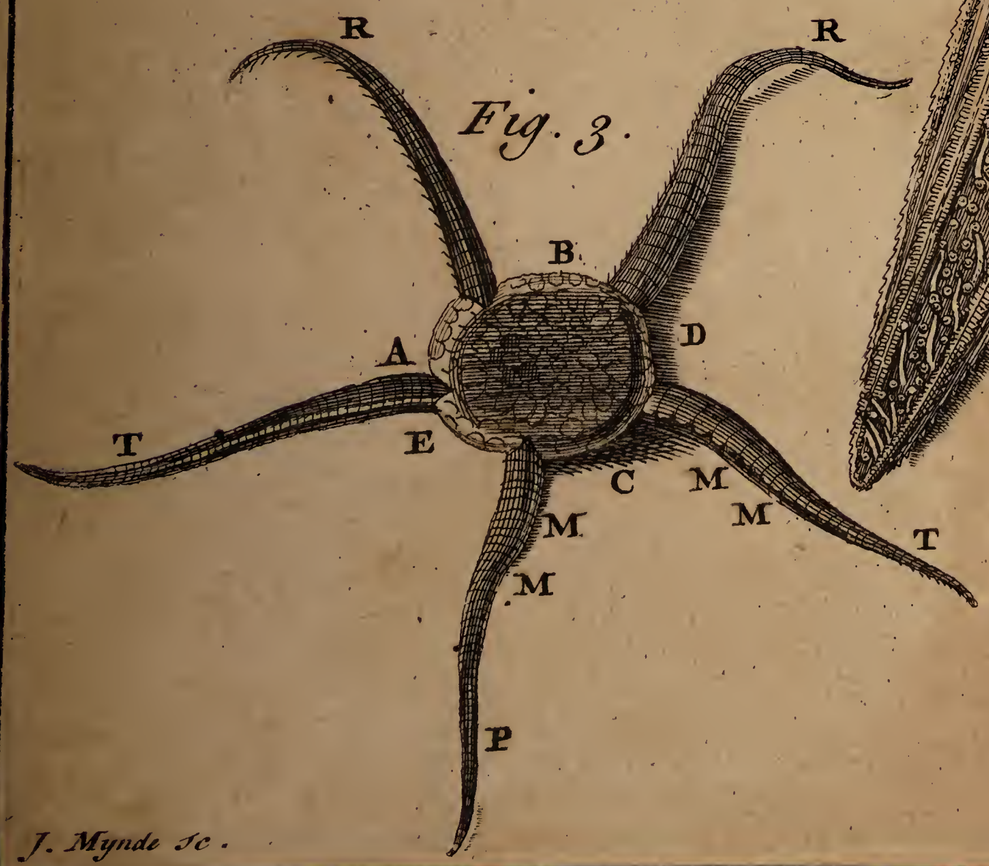


Fig. 5.

Fig. 4.

J. Mynde sc.

Fig. 3.

Fig. 2.

Fig. 1.

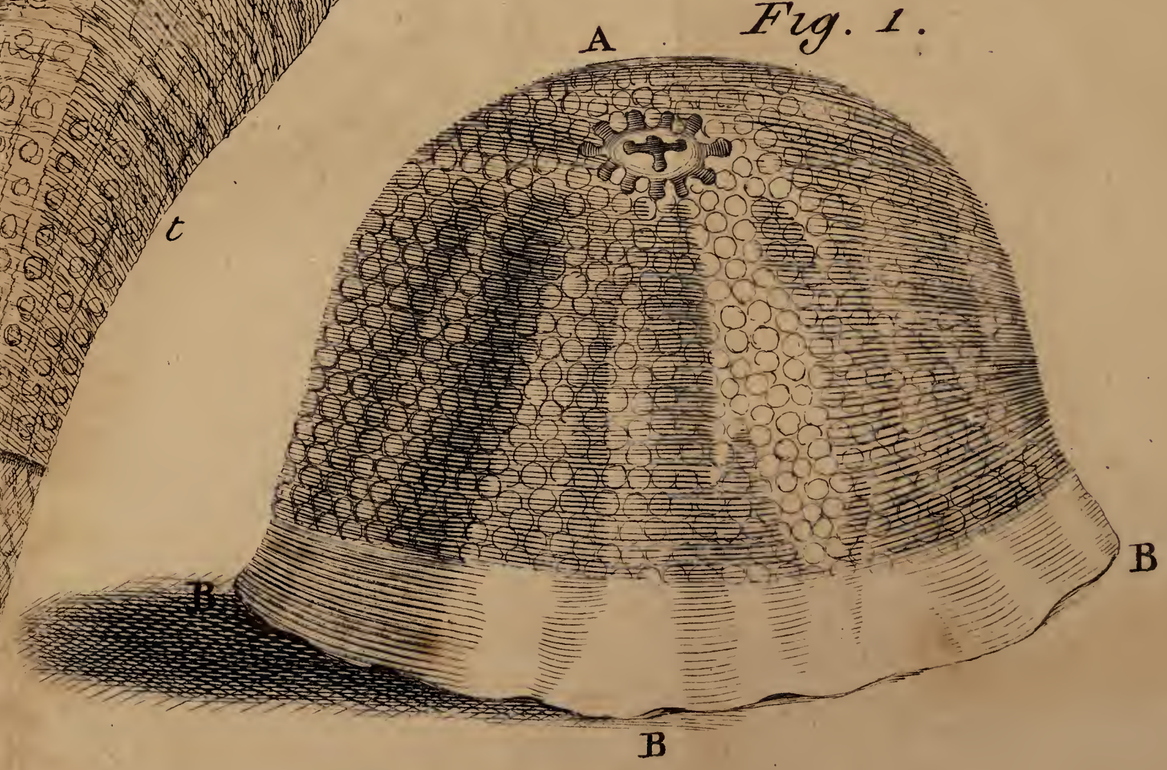
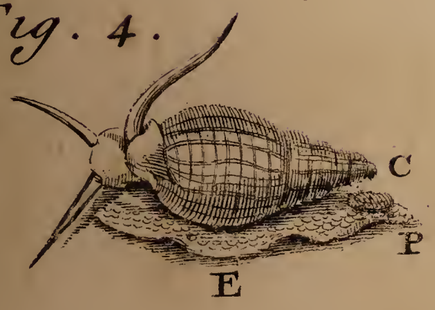


Fig. 4.



J. Mynde Sc.

Fig. 1.

J. Mynde sc.

Fig. 1.

Fig. 2.

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A MAP
of the
COUNTRY
where the Arc of
the Meridian
was
Measured.
Kittis
Cataract of Purus
Cat of Hirivas
Cat of Walkia
Lake of Pella
Pullugi
Niemi
The Polar
C. of Kattila
Circle.
G. of Somnia
Horrilakero
L. of Majama
L. of Waha
Parish of
Ofwer Tornea
Avaſaxa
Baſe-line
L. of Portimo
Cat of Portimo
L. of Kalli
L. Armas
Numisby
Cuitaperi
P. Anneræ
Ofwer Tornea
Cat of Wogena
Meridian of Kittis
Kakama
Cat of Matka
Niwa
Tornea R.
Kuckula
C. of Kukula
Liaska R.
Mattila
Sanga
TORNEA
Ch. of Finlanders
Nickala
Ch. of Kimi
Isle of Saſkar
GULF OF
BOTHNIA
R. of Kimi

J. Mynde sc.

A MAP OF THE COURSE OF THE MARAGNON OR GREAT RIVER OF AMAZONS

as far as it is navigable, from Jaen de Bracamoros to its Mouth, Comprehending also the province of QUITO, and the Coast of GUIANA, from the North Cape to Essequeba. Drawn in 1743 and 1744 and regulated by Astronomical Obſervations by MONS.R DE LA CONDAMINE of the Royal Academy of Sciences. Whereto is added the Course of Rio Negro, or the Black River, with other curious particulars, extracted from divers Memoirs, and Directories in Manuscripts of Modern Travellers.

SOUTH SEA
PART OF SOUTH AMERICA
NORTH SEA
DUTCH GUIANA
FRENCH GUIANA
PORTUGUEZE MISSIONS
SPANISH MISSIONS
BRAZIL
DOM K. OF NEW GRANADA
Sta Fe de Bogota
Western Longitude of the Meridian of ỹ Observatory at Paris.
Sea Leagues 20 to a Degree.
20 40 60 80 100
The Oroonoko running into ỹ North Sea
The Portugueze of Para in 1743 went up from ỹ River of Amazons, into that of Oroonoko, by Rio Negro.
EQUINOCTIAL LINE
Cape Corientes
Bay of Benaventura
River of
S. Juan
Cali
R. Cauca
River of St. Magdalen
R. de la Fragua
R. de Caguan
R. Caqueta or Yupura
R. Ijie
R. Yquiari
R. Putumayo
R. Cuiari
R. Yurubeth
R. Caiabubi
Lake Marahi Nuiſsi
Yupura
Aravida
Rio Negro Fort
Rio Blanco
R. Urubu
R. Jamundas
R. Trombetas
Streight of Pauxis
Fort Paru
Curupa Fort
R. Xingu
R. Tocantins
Isle of Joannes or Marayo
Para
Curupa
Cape Maguari
Port of Tigioca
Macapa Fort
Machiana Isle
Caviana Isle
North Cape
Maraca Isle
Bay of Vincent Pinco
R. Aravari
R. Irijo
Tapaco Nacheque
Camopi
Apruagua
Oyapoth Fort
Cape Orange
Kourou
Cayenne
The Constable
Surinam
Marony
Cayma
Essequeba River
R. Rupununi
Lake
R. Parima
R. Mahu
Pirara
Tacutu R.
Port Palmas
Cape Passado
La Canoa
Quito
Manta
Loronzo
Puerto Viejo
Charopoto
Tacunga
Amitado
Monte Christ
Helena
Gio
Compta
Guayaquil
Pte St.
Gulph of Guayaquil
Tumbez
Jarumi
Cuenca
Blanco
River Celac
Laza
Valladolid
R. St. Jago
St. Jago
Borja
Guaracayo
Loyola
Jaen
Escurrebragas
Sechura
Tomependa
Jaen of F. Fritz
Porto of F. Fritz
R. Chamaya
R. Marañon
R. Apena
R. Lagunas
R. Samiria
R. Cahuapanas
Ucayale
Yauari of F. Fritz
R. Yauari
Tomependa
Pongo of F. Fritz
Moyobamba
Chachapoyas
Rioja
Moreno
Pongo
Lamas
Tarapoto
Xeberos
Cahuapanas
Pevas
Nanay R.
Ica of F. Fritz
lower Ica
Iça
Huates
R. Napo
R. Aguarico
R. Coca
Avila
Baeza
Archidona
Napo
Canelos
Rebonaza
R. Pastaza
Andoas
R. Guayay
R. Macas
R. Zamora
R. Paute
R. Santiago
R. Morona
R. Pastaza
R. Tigre
R. Belleno
R. Ambyacu
R. Napo
Tiniaca
Cotopaxi
Tacunga
Ambato
Riobamba
Archidona
Macas
Sucumbios
Mocoa
Caqueta
Almaguer
Timana
Tacuba
Tarbacoas
River Pasto
River Mira
River Mayo
River of St. Iago
River of las Esmeraldas
Sucumbios
Mira
La Villa
Almaguer
Caqueta
Mocoa
Timana
Tacuba
Tarbacoas
River Pasto
Iça of F. Fritz
Evira
Tefe
Traquatea
Paraguari
Aracari
St. Paulo
St. Pedro
St. Joachim d'Omaguas
Yamcos
Cochiuara
Coari
Caldea
Cotiari
Purus
R. Madera
R. Abacachis
Canuma
R. Topaios
R. Madera of F. Fritz
R. Yuruapi
R. Yamundi
R. Yuruti
R. Yuta
R. Yavari
R. Yutay
R. Yurua
R. Jutay
R. Cuchiara
R. Cuchiavara
R. Purus
R. Coari
R. Caldea
R. Cotiari
R. Paraguari
R. Tefe
R. Guiriri
R. Xingu
R. Topayos of F. Fritz
R. Guanapu
R. Pacajus
R. Jocunda
R. Muju
R. Araguaya
R. of Tocantins
Itaboca Fall
Xingu of F. Fritz
Guiangue
Theantin
Para of F. Fritz
Curupa of F. Fritz
Tigioca
Port of
Isle of Joannes
or Marayo
Fort Paru
Curupa Fort
Streight of Pauxis
Fort
Rio Negro Fort
Macapa Fort
Machiana Isle
Caviana Isle
North Cape
North Cape of F. Fritz
Maraca Isle
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